SCIENCE

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FRIDAY, OCTOBER 6, 1899.

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*ADDRESS BY THE PRESIDENT OF THE BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.**

HE who until a few minutes ago was your president said somewhere at the meeting at Bristol, and said with truth, that among the qualifications needed for the high honor of Presidency of the British Association for the Advancement of Science, that of being old was becoming more and more dominant. He who is now attempting to speak to you feels that he is rapidly earning that distinction. But the Association itself is older than its President; it has seen pass away the men who, wise in their generation, met at York on September 27, 1831, to found it; it has seen other great men who in bygone years served it as presidents, or otherwise helped it on, sink one after another into the grave. Each year, indeed, when it plants its flag as a signal of its yearly meeting, that flag floats half-mast high in token of the great losses which the passing year has brought. This year is no exception; the losses, indeed, are perhaps unwontedly heavy. I will not attempt to call over the sad roll-call; but I must say a word about one who was above most others a faithful and zealous friend of the Association. Sir Douglas Galton joined the Association in 1860. From 1871 to 1895, as one of the General Secretaries, he bore, and bore to the great good of the Associa-

* Dover Meeting, 1899.

tion, a large share of the burden of the Association's work. How great that share was is perhaps especially known to the many men, among whom I am proud to count myself, who during his long term of office served in succession with him as brother General Secretary. In 1895, at Ipswich, he left the post of General Secretary, but only to become President. So long and so constantly did he labor for the good of the Association that he seemed to be an integral part of it, and meeting as we do to-day, and as we henceforward must do, without Douglas Galton, we feel something greatly missing. This year, perhaps even more than in other years, we could have wished him to be among us; for to-day the Association may look with joy, not unmixed with pride, on the realization of a project in forwarding which it has had a conspicuous share, on the commencement of an undertaking which is not only a great thing in itself, but which, we trust, is the beginning of still greater things to come. And the share which the Association has had in this was largely Sir Douglas Galton's doing. In his address as President of Section A, at the meeting of the Association at Cardiff in 1891, Professor Oliver Lodge expounded with pregnant words how urgently, not pure science only, but industry and the constructive arts—for the interests of these are ever at bottom the same—needed the aid of some national establishment for the prosecution of prolonged and costly physical researches, which private enterprise could carry out in a lame fashion only, if at all. Lodge's words found an echo in many men's minds; but the response was for a long while in men's minds only. In 1895, Sir Douglas Galton, having previously made a personal study of an institution analogous to the one desired—namely, the Reichsanstalt at Berlin—seized the opportunity offered to him as President of the Association at Ipswich to insist, with the authority not only of the head for the time being of a great scientific body, but also of one who himself knew the ways and wants at once of science and of practical life, that the thing which Lodge and others had hoped for was a thing which could be done, and ought to be done at once. And now to-day we can say it has been done. The National Physical Laboratory has been founded. The address at Ipswich marked the beginning of an organized effort which has at last been crowned with success. A feeling of sadness cannot but come over us when we think that Sir Douglas Galton was not spared to see the formal completion of the scheme whose birth he did so much to help, and which, to his last days, he aided in more ways than one. It is the old story—the good which men do lives after them.

Still older than the Association is this nineteenth century, now swiftly drawing to its close. Though the century itself has yet some sixteen months to run, this is the last meeting of the British Association which will use the numbers eighteen hundred to mark its date.

The eyes of the young look ever forward; they take little heed of the short though ever-lengthening fragment of life which lies behind them; they are wholly bent on that which is to come. The eyes of the aged turn wistfully again and again to the past; as the old glide down the inevitable slope their present becomes a living over again the life which has gone before, and the future takes on the shape of a brief lengthening of the past. May I this evening venture to give rein to the impulses of advancing years? May I, at this last meeting of the Association in the eighteen hundreds, dare to dwell for a while upon the past, and to call to mind a few of the changes which have taken place in the world since those autumn days in which men were saying to each other that the last

of the seventeen hundreds was drawing towards its end?

Dover in the year of our Lord seventeen hundred and ninety-nine was in many ways unlike the Dover of to-day. On moonless nights men groped their way in its narrow streets by the help of swinging lanterns and smoky torches, for no lamps lit the ways. By day the light of the sun struggled into the houses through narrow panes of blurred glass. Though the town then, as now, was one of the chief portals to and from the countries beyond the seas, the means of travel were scanty and dear, available for the most part to the rich alone, and, for all, beset with discomfort and risk. Slow and uncertain was the carriage of goods, and the news of the world outside came to the town—though it from its position learnt more than most towns—tardily, fitfully, and often falsely. The people of Dover sat then much in dimness, if not in darkness, and lived in large measure on themselves. They who study the phenomena of living beings tell us that light is the great stimulus of life, and that the fullness of the life of a being or of any of its members may be measured by the variety, the swiftness, and the certainty of the means by which it is in touch with its surroundings. Judged from this standpoint life at Dover then, as indeed elsewhere, must have fallen far short of the life of to-day.

The same study of living beings, however, teaches us that while from one point of view the environment seems to mould the organism, from another point the organism seems to be master of its environment. Going behind the change of circumstances, we may raise the question, the old question, Was life in its essence worth more then than now? Has there been a real advance?

Let me at once relieve your minds by saying that I propose to leave this question in the main unanswered. It may be, or it may not be, that man's grasp of the beautiful and of the good, if not looser, is not firmer than it was a hundred years ago. It may be, or it may not be, that man is no nearer to absolute truth, to seeing things as they really are, than he was then. I will merely ask you to consider with me for a few minutes how far, and in what ways, man's laying hold of that aspect of or part of truth which we call natural knowledge, or sometimes science, differed in 1799 from what it is to-day, and whether that change must not be accounted a real advance, a real improvement in man.

I do not propose to weary you by what in my hands would be the rash effort of attempting a survey of all the scientific results of the nineteenth century. It will be enough if for a little while I dwell on some few of the salient features distinguishing the way in which we nowadays look upon, and during the coming week shall speak of, the works of Nature around us—though those works themselves, save for the slight shifting involved in a secular change, remain exatcly the same—from the way in which they were looked upon and might have been spoken of at a gathering of philosophers at Dover in 1799. And I ask your leave to do so.

In the philosophy of the ancients, earth, fire, air, and water were called 'the elements.' It was thought, and rightly thought, that a knowledge of them and of their attributes was a necessary basis of a knowledge of the ways of Nature. Translated into modern language, a knowledge of these 'elements' of old means a knowledge of the composition of the atmosphere, of water, and of all the other things which we call matter, as well as a knowledge of the general properties of gases, liquids, and solids, and of the nature and effects of combustion. Of all these things our knowledge to-day is large and exact, and, though ever enlarging, in some respects complete. When did that knowledge begin to become exact?

To-day the children in our schools know that the air which wraps round the globe is is not a single thing, but is made up of two things, oxygen and nitrogen,* mingled together. They know, again, that water is not a single thing, but the product of two things, oxygen and hydrogen, joined together. They know that when the air makes the fire burn and gives the animal life, it is the oxygen in it which does the work. They know that all round them things are undergoing that union with oxygen which we call oxidation, and that oxidation is the ordinary source of heat and light. Let me ask you to picture to yourselves what confusion there would be to-morrow, not only in the discussions at the sectional meetings of our Association, but in the world at large, if it should happen that in the coming night some destroying touch should wither up certain tender structures in all our brains, and wipe out from our memories all traces of the ideas which cluster in our minds around the verbal tokens, oxygen and oxidation. How could any of us, not the so-called man of science alone, but even the man of business and the man of pleasure, go about his ways lacking those ideas? Yet those ideas were in 1799 lacking to all but a few.

Although in the third quarter of the seventeenth century the light of truth about oxidation and combustion had flashed out in the writings of John Mayow, it came as a flash only, and died away as soon as it had come. For the rest of that century, and for the greater part of the next, philosophers stumbled about in darkness, misled for the most of the time by the phantom conception which they called phlogiston. It was not until the end of the third quarter of the eighteenth century that the new light, which has burned steadily ever since, lit up the minds of the men of science. The light came at nearly the same time from England and from France. Rounding off the sharp corners of controversy, and joining, as we may fitly do to-day, the two countries as twin bearers of a common crown, we may say that we owe the truth to Cavendish, to Lavoisier, and Priestley. If it was Priestley who was the first to demonstrate the existence of what we now call oxygen, it is to Lavoisier we owe the true conception of the nature of oxidation and the clear exposition of the full meaning of Priestley's discovery, while the knowledge of the composition of water, the necessary complement of the knowledge of oxygen, came to us through Cavendish and, we may perhaps add, through Watt.

The date of Priestley's discovery of oxygen is 1774, Lavoisier's classic memoir 'on the nature of the principle which enters into combination with metals during calcination' appeared in 1775, and Cavendish's paper on the composition of water did not see the light until 1784.

During the last quarter of the eighteenth century this new idea of oxygen and oxidation was struggling into existence. How new was the idea is illustrated by the fact that Lavoisier himself at first spoke of that which he was afterwards, namely, in 1778, led to call oxygen, the name by which it has since been known, as 'the principle which enters into combination.' What difficulties its acceptance met with is illustrated by the fact that Priestley himself refused to the end of his life to grasp the true bearings of the discovery which he had made. In the year 1799 the knowledge of oxygen, of the nature of water and of air, and indeed the true conception of chemical composition and chemical change, was hardly more than beginning to be, and the century had to pass wholly away before the next great chemical idea, which we know by the name of the Atomic Theory of John Dalton, was made known. We have only to

*Some may already know that there is at least a third thing, argon.

read the scientific literature of the time to recognize that a truth which is now not only woven as a master-thread into all our scientific conceptions, but even enters largely into the everyday talk and thoughts of educated people, was a hundred years ago struggling into existence among the philosophers themselves. It was all but absolutely unknown to the large world outside those select few.

If there be one word of science which is writ large on the life of the present time, it is the word 'electricity'; it is, I take it, writ larger than any other word. The knowledge which it denotes has carried its practical results far and wide into our daily life, while the theoretical conceptions which it signifies pierce deep into the nature of things. We are to-day proud, and justly proud, both of the material triumphs and of the intellectual gains which it has brought us, and we are full of even larger hopes of it in the future.

At what time did this bright child of the nineteenth century have its birth?

He who listened to the small group of philosophers of Dover, who in 1799 might have discoursed of natural knowledge would perhaps have heard much of electric machines, of electric sparks, of the electric fluid, and even of positive and negative electricity; for frictional electricity had long been known and even carefully studied. Probably one or more of the group, dwelling on the observations which Galvani, an Italian, had made known some twenty years before, developed views on the connection of electricity with the phenomena of living bodies. Possibly one of them was exciting the rest by telling how he had just heard that a professor at Pavia, one Volta, had discovered that electricity could be produced not only by rubbing together particular bodies, but by the simple contact of two metals, and had thereby explained Galvani's remarkable results. For, indeed, as we shall hear from Professor Fleming, it was in that very year, 1799, that electricity as we now know it took its birth. It was then that Volta brought to light the apparently simple truths out of which so much has sprung. The world, it is true, had to wait for yet some twenty years before both the practical and the theoretic worth of Volta's discovery became truly pregnant, under the fertilizing influence of another discovery. The loadstone and magnetic virtues had, like the electrifying power of rubbed amber, long been an old story. But, save for the compass, not much had come from it. And even Volta's discovery might have long remained relatively barren had it been left to itself. When, however, in 1819, Oersted made known his remarkable observations on the relations of electricity to magnetism, he made the contact needed for the flow of a new current of ideas. And it is perhaps not too much to say that those ideas, developing during the years of the rest of the century with an ever-accelerating swiftness, have wholly changed man's material relations to the circumstances of life, and at the same time carried him far in his knowledge of the nature of things.

Of all the various branches of science, none perhaps is to-day, none for these many years past has been, so well known to, even if not understood by, most people as that of geology. Its practical lessons have brought wealth to many; its fairy tales have brought delight to more; and round it hovers the charm of danger, for the conclusions to which it needs touch on the nature of man's beginning.

In 1799, the science of geology, as we now know it, was struggling into birth. There had been from of old cosmogonies, theories as to how the world had taken shape out of primæval chaos. In that fresh spirit which marked the zealous search after natural knowledge pursued in the middle

and latter part of the seventeenth century, the brilliant Stenson, in Italy, and Hooke, in our own country, had laid hold of some of the problems presented by fossil remains, and Woodward, with others, had labored in the same field. In the eighteenth century, especially in its latter half, men's minds were busy about the physical agencies determining or modifying the features of the earth's crust; water and fire, subsidence from a primæval ocean and transformation by outbursts of the central heat, Neptune and Pluto, were being appealed to, by Werner on the one hand, and by Desmarest on the other, in explanation of the earth's phenomena. The way was being prepared, theories and views were abundant, and many sound observations had been made; and yet the science of geology, properly so called, the exact and proved knowledge of the successive phases of the world's life, may be said to date from the closing years of the eighteenth century.

In 1783, James Hutton put forward in a brief memoir his 'Theory of the Earth,' which in 1795, two years before his death, he expanded into a book; but his ideas failed to lay hold of men's minds until the century had passed away, when in 1802, they found an able expositor in John Playfair. The very same year that Hutton published his theory, Cuvier came to Paris and almost forth with began, with Brongniart, his immortal researches into the fossils of Paris and its neighborhood. And four years later, in the year 1799 itself, William Smith's tabular list of strata and fossils saw the light. It is, I believe, not too much to say that out of these geology, as we now know it, sprang. It was thus in the closing years of the eighteenth century that was begun the work which the nineteenth century has carried forward to such great results. But at this time only the select few had grasped the truth, and even they only the beginning of it. Outside a narrow circle the thoughts, even of the educated, about the history of the globe were bounded by the story of the Deluge—though the story was often told in a strange fashion—or were guided by fantastic views of the plastic forces of a sportive Nature.

In another branch of science, in that which deals with the problems presented by living beings, the thoughts of men in 1799 were also very different from the thoughts of men to-day. It is a very old quest, the quest after the knowledge of the nature of living beings, one of the earliest on which man set out; for it promised to lead him to a knowledge of himself, a promise which perhaps is still before us, but the fulfillment of which is yet far off. As time has gone on, the pursuit of natural knowledge has seemed to lead man away from himself into the furthermost parts of the universe, and into secret workings of Nature in which he appears to be of little or no account; and his knowledge of the nature of living things, and so of his own nature, has advanced slowly, waiting till the progress of other branches of natural knowledge can bring it aid. Yet in the past hundred years, the biologic sciences, as we now call them, have marched rapidly onward.

We may look upon a living body as a machine doing work in accordance with certain laws, and may seek to trace out the working of the inner wheels, how these raise up the lifeless dust into living matter, and let the living matter fall away again into dust, giving out movement and heat. Or we may look upon the individual life as a link in a long chain, joining something which went before to something about to come, a chain whose beginning lies hid in the farthest past, and may seek to know the ties which bind one life to another. As we call up to view the long series of living forms, living now or flitting like shadows on the screen of the past, we may strive to

lay hold of the influences which fashion the garment of life. Whether the problems of life are looked upon from the one point of view or the other, we to-day, not biologists only, but all of us, have gained a knowledge hidden even from the philosophers a hundred years ago.

Of the problems presented by the living body viewed as a machine, some may be spoken of as mechanical, others as physical, and yet others as chemical, while some are, apparently at least, none of these. In the seventeenth century William Harvey, laying hold of the central mechanism of the blood stream, opened up a path of inquiry which his own age and the century which followed trod with marked success. The knowledge of the mechanics of the animal and of the plant advanced apace, but the physical and chemical problems had yet to wait. The eighteenth century, it is true, had its physics and its chemistry; but in relation at least to the problems of the living being, a chemistry which knew not oxygen and a physics which knew not the electricity of chemical action were of little avail. The philosopher of 1799, when he discussed the functions of the animal or of the plant involving chemical changes, was fain for the most part, as were his predecessors in the century before, to have recourse to such vague terms as 'fermentation' and the like; to-day our treatises on physiology are largely made up of precise and exact expositions of the play of physical agencies and chemical bodies in the living organisms. He made use of the words 'vital force' or 'vital principle' not as an occasional, but as a common, explanation of the phenomena of the living body. During the present century, especially during its latter half, the idea embodied in those words has been driven away from one seat after another; if we use it now when we are dealing with the chemical and physical events of life, we use it with reluctance, as a *deus ex machina* to be appealed to only when everything else has failed.

Some of the problems—and those, perhaps, the chief problems—of the living body have to be solved neither by physical nor chemical methods, but by methods of their own. Such are the problems of the nervous system. In respect to these the men of 1799 were on the threshold of a pregnant discovery. During the latter part of the present century, and especially during its last quarter, the analysis of the mysterious processes in the nervous system, and especially in the brain, which issue as feeling, thought and the power to move, has been pushed forward with a success conspicuous in its practical, and full of promise in its theoretical, gains. That analysis may be briefly described as a following up of threads. We now know that what takes place along a tiny thread which we call a nerve-fiber differs from that which takes place along its fellow-threads, that differing nervous impulses travel along different nervous-fibers, and that nervous and psychical events are the outcome of the clashing of nervous impulses as they sweep along the closely-woven web of living threads of which the brain is made. We have learnt by experiment and by observation that the pattern of the web determines the play of the impulses, and we can already explain many of the obscure problems not only of nervous disease, but of nervous life, by an analysis which is a tracking out the devious and linked paths of nervous threads. The very beginning of this analysis was unknown in 1799. Men knew that nerves were the agents of feeling and of the movements of muscles; they had learnt much about what this part or or that part of the brain could do; but they did not know that one nerve-fiber differed from another in the very essence of its work. It was just about the end of the past century, or the beginning of the pres-

ent one, that an English surgeon began to ponder over a conception which, however, he did not make known until some years later, and which did not gain complete demonstration and full acceptance until still more years had passed away. It was in 1811, in a tiny pamphlet published privately, that Charles Bell put forth his 'New Idea' that the nervous system was constructed on the principle that "the nerves are not single nerves possessing various powers, but bundles of different nerves, whose filaments are united for the convenience of distribution, but which are distinct in office as they are in origin from the brain."

Our present knowledge of the nervous system is to a large extent only an exemplification and expansion of Charles Bell's 'New Idea,' and has its origin in that.

If we pass from the problems of the living organism viewed as a machine, to those presented by the varied features of the different creatures who have lived or who still live on the earth, we at once call to mind that the middle years of the present century mark an epoch in biologic thought such as never came before, for it was then that Charles Darwin gave to the world the 'Origin of Species.'

That work, however, with all the far-reaching effects which it has had, could have had little or no effect, or, rather, could not have come into existence, had not the earlier half of the century been in travail preparing for its coming. For the germinal idea of Darwin appeals, as to witnesses, to the results of two lines of biologic investigation which were almost unknown to the men of the eighteenth century.

To one of these lines I have already referred. Darwin, as we know, appealed to the geological record; and we also know how that record, imperfect as it was then, and imperfect as it must always remain, has since his time yielded the most striking proofs of at least one part of his general conception. In 1799 there was, as we have seen, no geological record at all.

Of the other line I must say a few words.

To-day the merest beginner in biologic study, or even that exemplar of acquaintance without knowledge, the general reader, is aware that every living being, even man himself, begins its independent existence as a tiny ball, of which we can, even acknowledging to the full the limits of the optical analysis at our command, assert with confidence that in structure, using that word in its ordinary sense, it is in all cases absolutely simple. It is equally well known that the features of form which supply the characters of a grown-up living being, all the many and varied features of even the most complex organism, are reached as the goal of a road, at times a long road, of successive changes; that the life of every being, from the ovum to its full estate, is a series of shifting scenes, which come and go, sometimes changing abruptly, sometimes melting the one into the other, like dissolving views, all so ordained that often the final shape with which the creature seems to begin, or is said to begin its life in the world is the outcome of many shapes, clothed with which it in turn has lived many lives before its seeming birth.

All or nearly all the exact knowledge of the labored way in which each living creature puts on its proper shape and structure is the heritage of the present century. Although the way in which the chick is moulded in the egg was not wholly unknown even to the ancients, and in later years had been told, first in the sixteenth century by Fabricius, then in the seventeeth century in a more clear and striking manner by the great Italian naturalist, Malpighi, the teaching thus offered had been neglected or misinterpreted. At the close of the eighteenth century the dominant view was that in the making of a crea-

ture out of the egg there was no putting on of wholly new parts, no epigenesis. It was taught that the entire creature lay hidden in the egg, hidden by reason of the very transparency of its substance, lay ready-made but folded up, as it were, and that the process of development within the egg or within the womb was a mere unfolding, a simple evolution. Nor did men shrink from accepting the logical outcome of such a view—namely, that within the unborn creature itself lay in like manner, hidden and folded up, its offspring also, and within that again its offspring in turn, after the fashion of a cluster of ivory balls carved by Chinese hands, one within the other. This was no fantastic view put forward by an imaginative dreamer; it was seriously held by sober men, even by men like the illustrious Haller, in spite of their recognizing that as the chick grew in the egg some changes of form took place. Though so early as the middle of the eighteenth century Friedrich Casper Wolff and, later on, others had strenuously opposed such a view, it held its own not only to the close of the century, but far on into the next. It was not until a quarter of the present century had been added to the past that Von Baer made known the results of researches which once and for all swept away the old view. He and others working after him made it clear that each individual puts on its final form and structure not by an unfolding of preëxisting hidden features, but by the formation of new parts through the continued differentiation of a primitively simple material. It was also made clear that the successive changes which the embryo undergoes in its progress from the ovum to maturity are the expression of morphologic laws, that the progress is one from the general to the special, and that the shifting scenes of embryonic life are hints and tokens of lives lived by ancestors in times long past.

If we wish to measure how far off in biologic thought the end of the last century stands, not only from the end, but even from the middle of this one, we may imagine Darwin striving to write the 'Origin of Species' in 1799. We may fancy him being told by philosophers explaining how one group of living beings differed from another group because all its members and all their ancestors came into existence at one stroke when the first-born progenitor of the race, within which all the rest were folded up, stood forth as the result of a creative act. We may fancy him listening to a debate between the philosopher who maintained that all the fossils strewn in the earth were the remains of animals or plants churned up in the turmoil of a violent universal flood, and dropped in their places as the waters went away, and him who argued that such were not really the 'spoils of living creatures,' but the products of some playful plastic power which out of the superabundance of its energy fashioned here and there the lifeless earth into forms which imitated, but only imitated, those of living things. Could he amid such surroundings by any flight of genius have beat his way to the conception for which his name will ever be known?

Here I may well turn away from the past. It is not my purpose, nor, as I have said, am I fitted, nor is this perhaps the place, to tell even in outline the tale of the work of science in the nineteenth century. I am content to have pointed out that the two great sciences of chemistry and geology took their birth, or at least began to stand alone, at the close of the last century, and have grown to be what we know them now within about a hundred years, and that the study of living beings has within the same time been so transformed as to be to-day something wholly different from what it was in 1799. And, indeed, to say more would

be to repeat almost the same story about other things. If our present knowledge of electricity is essentially the child of the nineteenth century, so also is our present knowledge of many other branches of physics. And those most ancient forms of exact knowledge, the knowledge of numbers and of the heavens, whose beginning is lost in the remote past, have, with all other kinds of natural knowledge, moved onward during the whole of the hundred years with a speed which is ever increasing. I have said, I trust, enough to justify the statement that in respect to natural knowledge a great gulf lies between 1799 and 1899. That gulf, moreover, is a two-fold one: not only has natural knowledge been increased, but men have run to and fro spreading it as they go. Not only have the few driven far back round the full circle of natural knowledge the dark clouds of the unknown which wrap us all about, but also the many walk in the zone of light thus increasingly gained. If it be true that the few to-day are, in respect to natural knowledge, far removed from the few of those days, it is also true that nearly all which the few alone knew then, and much which they did not know, has now become the common knowledge of the many.

What, however, I may venture to insist upon here is that the difference in respect to natural knowledge, whatever be the case with other differences between then and now, is undoubtedly a difference which means progress. The span between the science of that time and the science of to-day is beyond all question a great stride onwards.

We may say this, but we must say it without boasting. For the very story of the past which tells of the triumphs of science bids the man of science put away from him all thoughts of vainglory—and that by many tokens.

Whoever, working at any scientific problem, has occasion to study the inquiries into the same problem made by some fellow-worker in the years long gone by, comes away from that study humbled by one or other of two different thoughts. On the one hand he may find, when he has translated the language of the past into the phraseology of to-day, how near was his forerunner of old to the conception which he thought, with pride, was all his own, not only so true but so new. On the other hand, if the ideas of the investigator of old, viewed in the light of modern knowledge, are found to be so wide of the mark as to seem absurd, the smile which begins to play upon the lips of the modern is checked by the thought, Will the ideas which I am now putting forth, and which I think explain so clearly, so fully, the problem in hand, seem to some worker in the far future as wrong and as fantastic as do these of my forerunner to me? In either case his personal pride is checked. Further, there is written clearly on each page of the history of science, in characters which cannot be overlooked, the lesson that no scientific truth is born anew, coming by itself and of itself. Each new truth is always the offspring of something which has gone before, becoming in turn the parent of something coming after. In this aspect the man of science is unlike, or seems to be unlike, the poet and the artist. The poet is born, not made; he rises up, no man knowing his beginnings; when he goes away, though men after him may sing his songs for centuries, he himself goes away wholly, having taken with him his mantle, for this he can give to none other. The man of science is not thus creative; he is created. His work, however great it be, is not wholly his own; it is in part the outcome of the work of men who have gone before. Again and again a conception which has made a name great has come not so much by the man's own effort as out of the fullness of time. Again

and again we may read in the words of some man of old the outlines of an idea which in later days has shone forth as a great acknowledged truth. From the mouth of the man of old the idea dropped barren, fruitless; the world was not ready for it, and heeded it not; the concomitant and abutting truths which could give it power to work were wanting. Coming back again in later days, the same idea found the world awaiting it; things were in travail preparing for it: and someone, seizing the right moment to put it forth again, leapt into fame. It is not so much the men of science who make science, as some spirit which, born of the truths already won, drives the man of science onward and uses him to win new truths in turn.

It is because each man of science is not his own master, but one of many obedient servants of an impulse which was at work long before him, and will work long after him, that in science there is no falling back. In respect to other things there may be times of darkness and times of light, there may be risings, decadences and revivals. In science there is only progress. The path may not be always a straight line, there may be swerving to this side and to that, ideas may seem to return again and again to the same point of the intellectual compass; but it will always be found that they have reached a higher level—they have moved, not in a circle, but in a spiral. Moreover, science is not fashioned as is a house, by putting brick to brick, that which is once put remaining as it was put to the end. The growth of science is that of a living being. As in the embryo phase follows phase, and each member or body puts on in succession different appearances, though all the while the same member, so a scientific conception of one age seems to differ from that of a following age, though it is the same one in the process of being made; and as the dim outlines of the early embryo become, as the being grows more distinct and sharp, like a picture on a screen brought more and more into focus, so the dim gropings and searchings of the men of science of old are by repeated approximations wrought into the clear and exact conclusions of later times.

The story of natural knowledge, of science, in the nineteenth century, as, indeed, in preceding centuries, is, I repeat, a story of continued progress. There is in it not so much as a hint of falling back, not even of standing still. What is gained by scientific inquiry is gained forever; it may be added to, it may seem to be covered up, but it can never be taken away. Confident that the progress will go on, we cannot help peering into the years to come and straining our eyes to foresee what science will become and what it will do as they roll on. While we do so, the thought must come to us, Will all the increasing knowledge of Nature avail only to change the ways of man—will it have no effect on man himself?

The material good which mankind has gained and is gaining through the advance of science is so imposing as to be obvious to everyone, and the praises of this aspect of science are to be found in the mouths of all. Beyond all doubt science has greatly lessened and has markedly narrowed hardship and suffering; beyond all doubt science has largely increased and has widely diffused ease and comfort. The appliances of science have, as it were, covered with a soft cushion the rough places of life, and that not for the rich only, but also for the poor. So abundant and so prominent are the material benefits of science that in the eyes of many these seem to be the only benefits which she brings. She is often spoken of as if she were useful and nothing more, as if her work were only to administer to the material wants of man.

Is this so?

We may begin to doubt it when we reflect that the triumphs of science which bring these material advantages are in their very nature intellectual triumphs. The increasing benefits brought by science are the results of man's increasing mastery over Nature, and that mastery is increasingly a mastery of mind; it is an increasing power to use the forces of what we call inanimate nature in place of the force of his own or other creatures' bodies; it is an increasing use of mind in place of muscle.

Is it to be thought that that which has brought the mind so greatly into play has had no effect on the mind itself? Is that part of the mind which works out scientific truths a mere slavish machine producing results it knows not how, having no part in the good which in its working it brings forth?

What are the qualities, the features of that scientific mind which has wrought, and is working, such great changes in man's relation to Nature? In seeking an answer to this question we have not to inquire into the attributes of genius. Though much of the progress of science seems to take on the form of a series of great steps, each made by some great man, the distinction in science between the great discoverer and the humble worker is one of degree only, not of kind. As I was urging just now, the greatness of many great names in science is often, in large part, the greatness of occasion, not of absolute power. The qualities which guide one man to a small truth silently taking its place among its fellows, as these go to make up progress, are at bottom the same as those by which another man is led to something of which the whole world rings.

The features of the fruitful scientific mind are in the main three.

In the first place, above all other things, his nature must be one which vibrates in unison with that of which he is in search; the seeker after truth must himself be truthful, truthful with the truthfulness of Nature. For the truthfulness of Nature is not wholly the same as that which man sometimes calls truthfulness. It is far more imperious, far more exacting. Man, unscientific man, is often content with 'the nearly' and 'the almost.' Nature never is. It is not her way to call the same two things which differ, though the difference may be measured by less than a thousandth of a milligram or of a millimeter, or by any other like standard of minuteness. And the man who, carrying the ways of the world into the domain of science, thinks that he may treat Nature's differences in any other way than she treats them herself, will find that she resents his conduct; if he in carelessness or in disdain overlooks the minute difference which she holds out to him as a signet to guide him in his search, the projecting tip, as it were, of some buried treasure, he is bound to go astray, and the more strenuously he struggles on, the farther will he find himself from his true goal.

In the second place, he must be alert of mind. Nature is ever making signs to us, she is ever whispering to us the beginnings of her secrets; the scientific man must be ever on the watch, ready at once to lay hold of Nature's hint, however small, to listen to her whisper however low.

In the third place, scientific inquiry, though it be preëminently an intellectual effort, has need of the moral quality or courage—not so much the courage which helps a man to face a sudden difficulty as the courage of steadfast endurance. Almost every inquiry, certainly every prolonged inquiry, sooner or later goes wrong. The path, at first so straight and clear, grows crooked and gets blocked; the hope and enthusiasm, or even the jaunty ease, with which the inquirer set out, leave him

and he falls into a slough of despond. That is the critical moment calling for courage. Struggling through the slough he will find on the other side of the wicket-gate opening up the real path; losing heart he will turn back and add one more stone to the great cairn of the unaccomplished.

But, I hear someone say, these qualities are not the peculiar attributes of the man of science, they may be recognized as belonging to almost everyone who has commanded or deserved success, whatever may have been his walk of life. That is so. That is exactly what I would desire to insist, that the men of science have no peculiar virtues, no special powers. They are ordinary men, their characters are common, even commonplace. Science, as Huxley said, is organized common sense, and men of science are common men, drilled in the ways of common sense.

For their life has this feature. Though in themselves they are no stronger, no better than other men, they possess a strength which, as I just now urged, is not their own but is that of the science whose servants they are. Even in his apprenticeship, the scientific inquirer, while learning what has been done before his time, if he learns it aright, so learns it that what is known may serve him not only as a vantage ground whence to push off into the unknown, but also as a compass to guide him in his course. And when fitted for his work he enters on inquiry itself, what a zealous anxious guide, what a strict and, because strict, helpful school-mistress does Nature make herself to him! Under her care every inquiry, whether it bring the inquirer to a happy issue or seem to end in nought, trains him for the next effort. She so orders her ways that each act of obedience to her makes the next act easier for him, and step by step she leads him on towards that perfect obedience which is complete mastery.

Indeed, when we reflect on the potency of the discipline of scientific inquiry we cease to wonder at the progress of scientific knowledge. The results actually gained seem to fall so far short of what under such guidance might have been expected to have been gathered in that we are fain to conclude that science has called to follow her, for the most part, the poor in intellect and the wayward in spirit. Had she called to her service the many acute minds who have wasted their strength struggling in vain to solve hopeless problems, or who have turned their energies to things other than the increase of knowledge; had she called to her service the many just men who have walked straight without the need of a rod to guide them, how much greater than it has been would have been the progress of science, and how many false teachings would the world have been spared! To men of science themselves, when they consider their favored lot, the achievements of the past should serve not as a boast but as a reproach.

If there be any truth in what I have been urging, that the pursuit of scientific inquiry is itself a training of special potency, giving strength to the feeble and keeping in the path those who are inclined to stray, it is obvious that the material gains of science, great as they may be, do not make up all the good which science brings or may bring to man. We especially, perhaps, in these later days, through the rapid development of the physical sciences, are too apt to dwell on the material gains alone. As a child in its infancy looks upon its mother only as a giver of good things, and does not learn till in after days how she was also showing her love by carefully training it in the way it should go, so we, too, have thought too much of the gifts of science, overlooking her power to guide.

Man does not live by bread alone, and science brings him more than bread. It is

a great thing to make two blades of grass grow where before one alone grew; but it is no less great a thing to help a man to come to a just conclusion on the questions with which he has to deal. We may claim for science that while she is doing the one she may be so used as to do the other also. The dictum just quoted, that science is organized common sense, may be read as meaning that the common problems of life which common people have to solve are to be solved by the same methods by which the man of science solves his special problems. It follows that the training which does so much for him may be looked to as promising to do much for them. Such aid can come from science on two conditions only. In the first place, this her influence must be acknowledged; she must be duly recognized as a teacher no less than as a hewer of wood and a drawer of water. And the pursuit of science must be followed not by the professional few only, but, at least in such measure as will ensure the influence of example, by the many. But this latter point I need not urge before this great Association, whose chief object during more than half a century has been to bring within the fold of science all who would answer to the call. In the second place, it must be understood that the training to be looked for from science is the outcome not of the accumulation of scientific knowledge, but of the practice of scientific inquiry. Man may have at his fingers' ends all the accomplished results and all the current opinions of any one or of all the branches of science, and yet remain wholly unscientific in mind; but no one can have carried out even the humblest research without the spirit of science in some measure resting upon him. And that spirit may in part be caught even without entering upon an actual investigation in search of a new truth. The learner may be led to old truths, even the oldest, in more ways than one. He may be brought abruptly to a truth in its finished form, coming straight to it like a thief climbing over the wall; and the hurry and press of modern life tempt many to adopt this quicker way. Or he may be more slowly guided along the path by which the truth was reached by him who first laid hold of it. It is by this latter way of learning the truth, and by this alone, that the learner may hope to catch something at least of the spirit of the scientific inquirer.

This is not the place, nor have I the wish, to plunge into the turmoil of controversy; but, if there be any truth in what I have been urging, then they are wrong who think that in the schooling of the young, science can be used with profit only to train those for whom science will be the means of earning their bread. It may be that from the point of view of pedagogic art the experience of generations has fashioned out of the older studies of literature an instrument of discipline of unusual power, and that the teaching of science is as yet but a rough tool in unpracticed hands. That, however, is not an adequate reason why scope should not be given for science to show the value which we claim for it as an intellectual training fitted for all sorts and conditions of men. Nor need the studies of humanity and literature fear her presence in the schools, for if her friends maintain that the teaching is one-sided, and therefore misleading, which deals with the doings of man only, and is silent about the works of Nature, in the sight of which he and his doings shrink almost to nothing, she herself would be the first to admit that that teaching is equally wrong which deals only with the works of Nature and says nothing about the doings of man, who is, to us at least, Nature's center.

There is yet another general aspect of science on which I would crave leave to say

a word. In that broad field of human life which we call politics, in the struggle not of man with man, but of race with race, science works for good. If we look only on the surface it may at first sight seem otherwise. In no branch of science has there during these later years been greater activity and more rapid progress than in that which furnishes the means by which man brings death, suffering and disaster on his fellow-men. If the healer can look with pride on the increased power which science has given him to alleviate human suffering and ward off the miseries of disease, the destroyer can look with still greater pride on the power which science has given him to sweep away lives and to work desolation and ruin: while the one has slowly been learning to save units, the other has quickly learnt to slay thousands. But, happily. the very greatness of the modern power of destruction is already becoming a bar to its use, and bids fair—may we hope before long?—wholly to put an end to it; in the words of Tacitus, though in another sense, the very preparations for war, through the character which science gives them, make for peace.

Moreover, not in one branch of science only, but in all, there is a deep undercurrent of influence sapping the very foundations of all war. As I have already urged, no feature of scientific inquiry is more marked than the dependence of each step forward on other steps which have been made before. The man of science cannot sit by himself in his own cave weaving out results by his own efforts, unaided by others, heedless of what others have done and are doing. He is but a bit of a great system, a joint in a great machine, and he can only work aright when he is in due touch with his fellow-workers. If his labor is to be what it ought to be, and is to have the weight which it ought to have, he must know what is being done, not by himself, but by others, and by others not of his own land and speaking his tongue only, but also of other lands and of other speech. Hence it comes about that to the man of science the barriers of manners and of speech which pen men into nations become more and more unreal and indistinct. He recognizes his fellow-worker, wherever he may live, and whatever tongue he may speak, as one who is pushing forward shoulder to shoulder with him towards a common goal, as one whom he is helping and who is helping him. The touch of science makes the whole world kin.

The history of the past gives us many examples of this brotherhood of science. In the revival of learning throughout the sixteenth and seventeenth centuries, and some way on into the eighteenth century, the common use of the Latin tongue made intercourse easy. In some respects in those earlier days science was more cosmopolitan than it afterwards became. In spite of the difficulties and hardships of travel, the men of science of different lands again and again met each other face to face, heard with their ears, and saw with their eyes what their brethren had to say or show. The Englishman took the long journey to Italy to study there; the Italian, the Frenchman and the German wandered from one seat of learning to another; and many a man held a chair in a country not his own. There was help, too, as well as intercourse. The Royal Society of London took upon itself the task of publishing nearly all the works of the great Italian Malpighi, and the brilliant Lavoisier, two years before his own countrymen in their blind fury slew him, received from the same body the highest token which it could give of its esteem.

In these closing years of the nineteenth century this great need of mutual knowledge and of common action felt by men of science of different lands is being mani-

fested in a special way. Though nowadays what is done anywhere is soon known everywhere, the news of a discovery being often flashed over the globe by telegraph, there is an increasing activity in the direction of organization to promote international meetings and international coöperation. In almost every science inquirers from many lands now gather together at stated intervals in international congresses to discuss matters which they have in common at heart, and go away each one feeling strengthened by having met his brother. The desire that in the struggle to lay bare the secrets of Nature the least waste of human energy should be incurred is leading more and more to the concerted action of nations combining to attack problems the solution of which is difficult and costly. The determination of standards of measurement, magnetic surveys, the solution of great geodetic problems, the mapping of the heavens and of the earth—all these are being carried on by international organizations.

In this and in other countries men's minds have this long while past been greatly moved by the desire to make fresh efforts to pierce the dark secrets of the forbidding Antarctic regions. Belgium has just made a brave single-handed attempt; a private enterprise sailing from these shores is struggling there now, lost for the present to our view; and this year we in England and our brethren in Germany are, thanks to the promised aid of the respective Governments, and no less to private liberality, in which this Association takes its share, able to begin the preparation of carefully organized expeditions. That international amity of which I am speaking is illustrated by the fact that in this country and in that there is not only a great desire, but a firm purpose, to secure the fullest coöperation between the expeditions which will leave the two shores. If in this momentous attempt any rivalry be shown between the two nations, it will be for each a rivalry, not in forestalling, but in assisting the other. May I add that if the story of the past may seem to give our nation some claim to the seas as more peculiarly our own, that claim bespeaks a duty likewise peculiarly our own to leave no effort untried by which we may plumb the seas' yet unknown depths and trace their yet unknown shores? That claim, if it means anything, means that when nations are joining hands in the dangerous work of exploring the unknown South, the larger burden of the task should fall to Britain's share; it means that we in this country should see to it, and see to it at once, that the concerted Antarctic expedition which in some two years or so will leave the shores of Germany, of England, and, perhaps, of other lands, should, so far as we are concerned, be so equipped and so sustained that the risk of failure and disaster may be made as small, and the hope of being able not merely to snatch a hurried glimpse of lands not yet seen, but to gather in with full hands a rich harvest of the facts which men not of one science only, but of many, long to know, as great as possible.

Another international scientific effort demands a word of notice. The need which every inquirer in science feels to know, and to know quickly, what his fellow-worker, wherever on the globe he may be carrying on his work or making known his results, has done or is doing, led some four years back to a proposal for carrying out by international coöperation a complete current index, issued promptly, of the scientific literature of the world. Though much labor in many lands has been spent upon the undertaking, the project is not yet an accomplished fact. Nor can this, perhaps, be wondered at, when the difficulties of the task are weighed. Difficulties of language, difficulties of driving in one team all the

several sciences which, like young horses, wish each to have its head free with leave to go its own way, difficulties mechanical and financial of press and post, difficulties raised by existing interests—these and yet other difficulties are obstacles not easy to be overcome. The most striking and the most encouraging features of the deliberations which have now been going on for three years have been the repeated expressions, coming not from this or that quarter only, but from almost all quarters, of an earnest desire that the effort should succeed, of a sincere belief in the good of international coöperation, and of a willingness to sink as far as possible individual interests for the sake of the common cause. In the face of such a spirit we may surely hope that the many difficulties will ultimately pass out of sight.

Perhaps, however, not the least notable fact of international coöperation in science is the proposal which has been made within the last two years that the leading academies of the world should, by representatives, meet at intervals to discuss questions in which the learned of all lands are interested. A month hence a preliminary meeting of this kind will be held at Wiesbaden; and it is at least probable that the closing year of that nineteenth century in which science has played so great a part may at Paris during the great World's Fair—which every friend, not of science only, but of humanity, trusts may not be put aside or even injured through any untoward event, and which promises to be an occasion not of pleasurable sight-seeing only, but also, by its many international congresses, of international communing in the search for truth—witness the first select Witenagemote of the science of the world.

I make no apology for having thus touched on international coöperation. I should have been wanting, had I not done so, on the memorable occasion of this meeting. A hundred years ago two great nations were grappling with each other in a fierce struggle, which had lasted, with pauses, for many years, and was to last for many years to come; war was on every lip and in almost every heart. To-day this meeting has, by a common wish, been so arranged that those two nations should in the persons of their men of science draw as near together as they can, with nothing but the narrow streak of the Channel between them, in order that they may take counsel together on matters in which they have one interest and a common hope. May we not look upon this brotherly meeting as one of many signs that science, though she works in a silent manner and in ways unseen by many, is steadily making for peace?

Looking back, then, in this last year of the eighteen hundreds, on the century which is drawing to a close, while we may see in the history of scientific inquiry much which, telling the man of science of his shortcomings and his weakness, bids him be humble, we also see much, perhaps more, which gives him hope. Hope is indeed one of the watchwords of science. In the latter-day writings of some who know not science, much may be read which shows that the writer is losing or has lost hope in the future of mankind. There are not a few of these; their repeated utterances make a sign of the times. Seeing in matters lying outside science few marks of progress and many tokens of decline or decay, recognizing in science its material benefits only, such men have thoughts of despair when they look forward to the times to come. But if there be any truth in what I have attempted to urge to-night, if the intellectual, if the moral influences of science are no less marked than her material benefits, if, moreover, that which she has done is but the earnest of that which she shall do, such men may pluck up courage and gather strength by laying hold of her garment.

We men of science at least need not share their views or their fears. Our feet are set, not on the shifting sands of the opinions and of the fancies of the day, but on a solid foundation of verified truth, which by the labors of each succeeding age is made broader and more firm. To us the past is a thing to look back upon, not with regret, not as something which has been lost never to be regained, but with content, as something whose influence is with us still, helping us on our further way. With us, indeed, the past points not to itself, but to the future; the golden age is in front of us, not behind us; that which we do know is a lamp whose brightest beams are shed into the unknown before us, showing us how much there is in front and lighting up the way to reach it. We are confident in the advance because, as each one of us feels that any step forward which he may make is not ordered by himself alone and is not the result of his own sole efforts in the present, but, is, and that in large measure, the outcome of the labors of others in the past, so each one of us has the sure and certain hope that as the past has helped him, so his efforts, be they great or be they small, will be a help to those to come.

Michael Foster.

INTERNATIONAL CATALOGUE OF SCIENTIFIC LITERATURE.

REPORT OF THE PROVISIONAL INTERNATIONAL COMMITTEE.

At the Second International Conference held in October, 1898, Professors Armstrong, Descamps and M. Foster, Dr. S. P. Langley, Professors Poincaré, Rücker, Waldeyer and Weiss were appointed to act as a Provisional International Committee, power being given to them to appoint substitutes, if any of those named were unable to serve, and also to co-opt two new members.

The delegates attending the Conference were requested to take steps in their respective countries to organize local committees charged with the study of all questions relating to the International Catalogue of Scientific Literature, and to report within six months to the Provisional International Committee. The delegates were also requested to obtain information and to report at an early date to the Provisional International Committee as to what assistance, by subscription or otherwise, towards the support of the Central Bureau may be expected from their respective countries.

The Provisional International Committee was instructed to frame a report, not later than July 31, 1899, which was to be issued by the Royal Society, and incorporated in the decisions of the Conference.

The Committee decided to co-opt an Italian and a Russian member. The Russian Government accepted the invitation, and, on the nomination of the Imperial Academy of Sciences, Mons. Th. P. Köppen, Librarian of the Imperial Public Library, St. Petersburg, became a member of the Committee.

The Committee received unofficial information that the Italian government proposed to nominate a delegate, but that he could not attend the present meeting of the Committee.

Professor Waldeyer being unable to serve, the German government appointed Professor Schwalbe in his place, but requested that he might be accompanied by Professor Klein their two delegates to have but one vote.

The Committee met in London at the Rooms of the Royal Society on August 1–5, 1899.

The following attended: Professor H. E. Armstrong, Sir M. Foster, Professor F. Klein, Mons. Th. P. Köppen, Professor H. Poincaré, Professor A. W. Rücker, Professor B. Schwalbe, Professor E. Weiss.

It was agreed—"That each country represented on the Committee has only one vote."

Reports upon the scheme for the International Catalogue prepared by the Royal Society, framed in pursuance of Resolution 21, of the Conference of 1898, which had been forwarded from the following countries, namely: Austria, Belgium, France, Germany, Netherlands, Sweden, Switzerland, United States of America, together with statements of the steps proposed to be taken for carrying out the Catalogue in India, Japan and Mexico, were received and fully considered by the Committee in the course of the meeting.

A discussion then took place on the following conditions, laid down by the German government, as those under which alone Germany was prepared to take part in the enterprise:

1. Die sachlichen Nachweise (subject entries) sollen wegfallen und in der unter III, 2 gegebenen Einschränkung durch die Anwendung mehrfacher Ordnungssymbole ersetzt werden.

2. Bei der Festlegung der den Titeln im System zukommenden Plätze durch Ordnungssymbole soll im Allgemeinen die Regel gelten, dass jeder Titel nur an einer Stelle unterzubringen ist.

3. Der sachlich geordnete Theil der Buchausgabe soll in allen Disziplinen lediglich aus den Titeln zusammengestellt werden, und zwar ausnahmslos unter Voranstellung des Verfassernamens.

4. Die Zettelausgabe soll als offizieller Theil des Unternehmens wegfallen.

5. Die Beitrittserklärung soll zunächst nur auf fünf Jahre erfolgen.

It was Resolved:

1. That the issue of a Card Catalogue be postponed for the present.

2. That a paper shall be entered in the Catalogue in more places than one only when this is rendered desirable by its scientific contents. No exact limits to the numbers of entries to be allowed to single papers can at present be fixed. This must be determined by the Central Bureau after adequate experience. Until such limits are determined, if the Central Bureau is of the opinion that in the returns made by any regional bureau the numbers of entries to single papers do not correspond to the scientific contents, it shall be its duty to intervene; such intervention, however, to be based not on individual cases, but upon an average. As regards the order of arrangement of entries in the final sub-divisions, in general this shall be in accordance with authors' names, except the subject demand other treatment.

The English members thereupon made the following statement:

The conditions under which the German Government agree to take part in the establishment of the Catalogue, viz.:

(A) That in general each title should be entered in one place only; and

(B) That 'subject entries' and 'significant words' must not be used,

differ so materially from the scheme formulated by the two Conferences, and so seriously affect the whole character of the enterprise, that the English members feel that they have no power to accept them without consulting the Royal Society upon the matter.

With respect to (A), if the condition be interpreted in accordance with the decision arrived at by the International Committee in Resolution 2 (see above), the difficulty is materially lessened.

With respect to (B), however, they feel sure that the restriction of entries to titles only will so largely diminish the value of the Catalogue, bringing it below that of various indices and reports already existing, and hence so lessen the sale as to render the financial success of the enterprise extremely doubtful, if not impossible.

They quite understand the reasons which have led the German Government to pro-

pose the restrictions in question, but they are of opinion that those reasons do not necessarily hold good for all countries.

And the objections which they entertain to the proposal would be lessened if liberty were given to individual Regional Bureaux when they find it necessary or desirable, in one or more of the places in which a paper is referred to, to make use of modified titles describing the contents of the paper better than the title itself. The extent to which such use of modified titles can be made must, of course, be subject to the control of the International Catalogue Council.

The English members cannot assume that even if it be thus changed, the conditions proposed by the German Government will be accepted by the Royal Society; but they desire, before bringing the whole matter before the Royal Society, to be informed of the views of the German Government in respect to the proposed change.

Moreover, so grave a departure from the scheme for providing a Catalogue, which should unquestionably be the best of its kind, could only be recommended if all the principal countries also consent. In particular, as the American delegate was unfortunately unable to attend the Conference, it will be necessary that the whole question at issue should be communicated to him, and that American opinion should be ascertained.

The German delegates expressed their willingness to submit this statement to their Government.

It was Resolved:—That separate schedules shall be provided for the following branches of science:

A. Mathematics.
B. Mechanics.
C. Physics.
D. Chemistry.
E. Astronomy.
F. Meteorology (including Terrestrial Magnetism).
G. Mineralogy (including Petrology and Crystallography).
H. Geology.
J. Geography (Mathematical and Physical).
K. Paleontology.
L. General Biology.
M. Botany.
N. Zoology.
O. Human Anatomy.
P. Physical Anthropology.
Q. Physiology (including Psychology, Pharmacology and Experimental Pathology).
R. Bacteriology.

And that the branches of Science be indicated by the letters of the alphabet in consecutive order as registration letters.

Schemes for Physics, Mineralogy, Petrology, Crystallography, Geology, Paleontology, Geography, Botany, Zoology and Physiology were adopted; and schemes for Mathematics, Mechanics, General Biology, Chemistry, Human Anatomy, Psychology, Bacteriology, Physical Anthropology, Astronomy and Meteorology were also approved for adoption, subject to the introduction of minor alterations by Committees to whom they were referred with the instruction to complete such revision and return the schemes to the Royal Society by the end of September at latest.

A general introductory section common to all sciences was adopted.

It was agreed that complete lists of new species would be required in the case of several of the sciences.

With reference to the cataloguing of the applications of science—

It was Resolved:—That technical matters of scientific interest shall be included in the catalogue, but shall be referred to under the appropriate scientific headings.

It was Resolved:—That a general list of journals indexed in the Catalogue, with the abbreviations to be used as references, be issued with the first edition of the Catalogue, and that a supplement giving the additions to this list be issued annually,

and a new edition at the end of five years.

With regard to the frequency of publication of the parts of the Catalogue, it was agreed:

(1) That a volume in each subject be published at least once a year.

(2) That it is desirable that in certain sciences there shall be a bi-monthly or quarterly issued of the Subject Catalogue.

It was Resolved:—That the registration system proposed by the Royal Society be adopted for tentative use in the Catalogue; and that an alphabetical key of the schedules of classification similar to that illustrated in the Netherlands report shall be issued with each annual volume together with the appropriate schedule, printed in the official languages, to be supplied as may be required.

The establishment of the Central Bureau having been considered:

"It was agreed to recommend that the Royal Society be requested to organize the Central Bureau and to do all work, including framing estimates and obtaining tenders, preliminary to the publication of the Catalogue in 1901; but that it shall act in concert with the International Council so soon as this shall be established."

The English members of the Committee made the following statement with reference to this resolution:

Previous to the actual issue of the Catalogue, the following money responsibilities must be incurred:

(1) Initial expenses connected with the Central Bureau, such as securing rooms, furniture, payment of officials before the first issue, etc.

(2) Contracts for printing the catalogue and other contracts which it may be necessary to make. With respect to the contracts, they could probably be obtained more cheaply if made for the whole of the five years for which the experiment of issuing the catalogue is to be tried. It would be very difficult to make, for one year only, contracts which may involve the purchase of new machinery, etc., by the printer. The total financial responsibility thus incurred cannot be estimated at less than £10,000. Moreover, it is possible, though we hope improbable, that the scheme may fail, and that the various countries concerned may wish to abandon it. The question therefore arises, who is to be responsible for any sums which might in such a case be due to the printer, or to others with whom contracts had been made?

The question has been raised whether the Royal Society would be willing to act in the matter.

On this we must remark that even if the Society were to act as a Provisional International Council, no contracts can be signed until after the next Conference (presumably held at Easter, 1900) has decided whether bi-monthly or quarterly parts shall be issued, or whether the total sum to be spent annually shall be limited to a fixed amount.

Hence, no great saving of time would result even if the Royal Society were willing to take a very heavy responsibility. On the whole, therefore, we propose that if and when the regions represented on the Provisional International Committee have assented to its proposals, these proposals shall be communicated to all the countries represented at the last Conference, that they shall be asked to organize their Regional Bureaux and nominate their representatives on the International Council in anticipation of the result of the next Conference, and that the International Council should meet immediately after the Conference.

This International Council would then take up, together with the management, all the necessary financial responsibilities.

Meanwhile the Royal Society would undertake all preliminary steps, obtain tenders,

and lay them before the International Council at its first meeting.

If this would allow the first issue to take place early in 1901, the desired object will be gained, but no greater speed will be attained by entrusting more responsibility to the Royal Society as it could not make definite contracts till after the next Conference.

It was agreed that the resolution preceding this statement shall be interpreted in accordance therewith.

The English members of the Committee undertook to bring the resolution under the notice of the Royal Society, and the other members to call the attention of their governments thereto.

After full consideration, the following statement as to the financial position was adopted:

The finances of the Catalogue will be controlled by the International Council, which, in accordance with regulations adopted by the International Conference of 1898 (Report 27, p. 11), will be bound to "make a report of its doings, and submit a balance sheet, copies of which shall be distributed to the several Regional Bureaux, etc."

The plan which seems the most generally favored is that the contributions of the Regional Bureaux shall take the form of undertakings to purchase a certain number of copies of the Catalogue annually. Various estimates point to the fact that the average contribution thus made by Regional Bureaux of the first rank (which may be called a whole share) will be equivalent to between one-eighth and one-tenth of the whole cost of producing the Book Catalogue.

For the purposes of this report, sales to private persons are not considered, or are supposed to be included in the sum guaranteed by each constituent country. In some cases the Regional Bureau will probably sell to individuals, either directly or through a publisher, those volumes which it does not dispose of to institutions, and will thus take the risk of the private sales. Whether this plan be adopted elsewhere or not, it is essential that the number of copies which constituent countries undertake to purchase shall together cover the cost of the production of the Catalogue.

Taking the original estimate formed by the Royal Society, the cost of the Book Catalogue would be £5,600 annually, so that a whole share would be between £700 and £560 per annum. If the lowest remunerative number of sales is equivalent to 350 complete subscriptions at £16 each, this would mean that a whole share entailed the purchase of between 44 and 35 complete sets or an equivalent.

These figures are, however, based upon assumptions which will require revision. The Card Catalogue will, no doubt, be abandoned, and it is proposed that it should be replaced by bi-monthly or quarterly issues. This, therefore, is an expense which has not been allowed for. The number of volumes has been increased from 16 to 17. There is also a general opinion that the estimates of the number of papers to be dealt with on which the original financial estimates were based were too small. Until all these matters have been fully considered and fresh estimates prepared, it appears to be impossible to say more than that it is hoped that the cost of a whole share will not be very much greater than the original estimates.

Estimates on the new conditions will be prepared and circulated during the autumn.

There are, however, three other points to consider:

It will be necessary to establish the Central Bureau and to appoint the officials some months before the first issue of the Catalogue begins. Funds for this purpose, which may be estimated at £2,500, are not included in the annual balance sheet which alone has been prepared.

Further, serious responsibility may also arise on the points referred to in the above statement of the representatives of the Royal Society.

Again, if the subscriptions are paid at the end and not at the beginning of the first year, it will be necessary to borrow funds, the interest on which will be a charge on the undertaking.

Again, if some countries refuse to form Regional Bureaux or to join in the enterprise, their literature will have to be dealt with by the Central Bureau. The cost of this cannot be estimated until it is definitely known whether the International Catalogue will be universally supported.

It was agreed that in reporting to the various governments and bodies concerned, special stress should be laid on the importance of organizing Regional Bureaux without delay.

The English delegates were requested:

(1) To have the schedules approved by this Committee reprinted and issued as soon as possible.

(2) To prepare an amended estimate of the cost of the Catalogue.

(3) To issue a complete programme based on the proceedings of the two Conferences and of this Committee.

(4) To fully inform all countries whose coöperation is desired.

It was agreed to recommend:

(1) That an International Conference, to arrive at a final decision on all matters concerning the Catalogue, be held at Eastertide, 1900.

(2) That the delegates attending this Conference should be charged with full powers to determine both financial and other questions.

(3) That those chosen to act on the International Council should be delegates to this Conference.

It was agreed—

"That the members of the Committee be requested to endeavor to obtain from their respective Governments authority to place themselves in direct communication with the Royal Society, as the official channel of communication for all further provisional correspondence on the subject of the Catalogue."

HENRY E. ARMSTRONG.
M. FOSTER.
F. KLEIN.
TH. P. KÖPPEN.
H. POINCARÉ.
ARTHUR W. RÜCKER.
B. SCHWALBE.
E. WEISS.

AUGUST 5, 1899.

SECTION E.—GEOLOGY AND GEOGRAPHY OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

THE address of the Chairman, Mr. J. F. Whiteaves on 'The Devonian System in Canada' has already been printed in SCIENCE. The papers presented were as follows:

'The Geology of Columbus and Vicinity,' Edward Orton, Columbus, Ohio.

An informal presentation of the facts in connection with the geology of Columbus and vicinity, designed to suggest points, of special interest to the visiting geologists. One matter to which particular attention was called was the occurrence of bowlders of native copper, derived from the Keewenaw copper region. Blocks of Marquette iron ore have also been sparingly found.

'Glacial phenomena of Central Ohio,' Frank Leverett, Denmark, Ohio.

A general description of the glacial and interglacial formations of Central Ohio, designed, in part, to cover the region in the vicinity of Lancaster, Ohio, to which an excursion was subsequently made.

The formations recognized in the description are:

1. The Illinoisan drift; 2. A soil and weathered zone (Sangamon) formed on

the surface of the latter; 3. A silt deposit, probably of Iowan age, which caps the weathered surface of the Illinoisan drift; 4. The Wisconsin drift with its several moraines. Lobation of the ice sheet in the Scioto basin; direction of striæ, and changes of drainage produced by glaciation are also discussed.

'Lateral Erosion at the Mouth of the Niagara Gorge,' G. Frederick Wright, Oberlin, Ohio.

The results of an accurate survey of the east face of the gorge are given, affording an opportunity to compare the present face of the gorge with that presented in 1854 and furnishing a standard datum for future comparisons. The rate of erosion thus determined seems to favor shorter chronologies for the age of the gorge.

'Age and Development of the Cincinnati Anticline,' August F. Foerste, Dayton, Ohio.

Along the axis of the Cincinnati anticline, from Stanford in Lincoln County to near Lebanon in Marion County, Kentucky, the Devonian rests on the Ordovician. On the western flank of the anticline the Devonian rests, first on the lowest member of the Silurian (the Clinton) then on the successively higher members, the Niagara, Osgood shale, Laurel limestone, Waldron shale and Louisville limestone. On the eastern flank it rests first upon the Clinton next upon the Osgood shales. The formation of the anticline began previous to the deposition of the Devonian. Its growth was arrested during late Silurian and early Devonian times and a large area above sea level was reduced to a peneplain. On this peneplain the Devonian limestone was subsequently deposited, but unevenly, owing to the inequalities of the peneplain. The Devonian black shale however was deposited over the entire anticline. This formation contains marine fossils at its base and land plants over the anticline region. These are generally believed to be the remains of the earliest land plants. After the deposition of the Devonian the folding continued, the maximum taking place in post-Devonian times. The facts seem to indicate that the anticline was not in existence during Clinton and Osgood times, but that it began in late Silurian to early Devonian time and had its maximum development in post-Devonian time.

'The Silurian-Devonian Boundary in North America,' Henry S. Williams, New Haven Conn.

'The Section at Schoharie, N. Y., John J. Stevenson, New York, N. Y.

'The Geological Results of the Indiana Coal Survey,' George H. Ashley, Indianapolis, Ind.

'The Cape Fear Section in the Coastal Plain,' J. A. Holmes, Chapel Hill, N. C.

'Triassic Coal and Coke of Sonora, Mexico,' E. T. Dumble, Houston, Tex.

'Some Geologic Conditions Favoring Water Power Developments in the South Atlantic Region,' J. A. Holmes, Chapel Hill, N. C.

The 'fall line' between the coastal plain and the Piedmont plateau is the zone where the most favorable geologic conditions for the development of water power are found. In the region of the crystalline schists the lesser geologic boundary lines, separating belts of slates, schists, granites, etc.; shearing lines or zones and fault lines, supply favorable conditions on a smaller scale. Within certain areas of bedded or schistose rocks, variations in the composition and obduracy of the rock masses furnish suitable conditions.

(*a*) '*Paropsonema:* A Peculiar Echinoderm from the Intumescens Fauna, New York.'

(*b*) 'Remarkable Occurrence of Orthoceros in the Oneonta Sandstones of New York.'

(*c*) 'The Squaw Island Water Biscuit, Canandaigua Lake, New York.'

John M. Clarke, Albany, N. Y.

Paropsonema represents an extraordinary type of echinoderm structure. It is believed to be an echinoid. The description was illustrated with drawings.

Extending over several square miles in the Chenango Valley, N. Y., a stratum of Oneonta sandstone occurs, in which are found thousands of *Orthocerata* standing erect and perpendicular to the bedding planes. They are the only truly marine organisms in the sandstone. Specimens were shown.

The so-called 'water biscuit' are probably concretions due to the effect of aquatic vegetation of low order, producing a precipitation of lime from the water. Specimens were shown.

'The Pot Holes of Foster's Flats (now called Niagara Glen) in the Niagara River,' Miss Mary A. Fleming, Buffalo, N. Y.

The discovery of pot holes at Foster's Flats is recorded, together with their location and the general appearance of the surroundings. They occur in large fragments which have fallen from the adjacent cliffs and were apparently formed while the fragments were part of the cliffs.

'A Consideration of the Interpretation of Unusual Events in Geologic Records, Illustrated by Recent Examples,' Frederick W. Simonds, Austin, Tex.

An examination of geologic reports shows that, as a rule, the working geologist devotes too little time to the *interpretation of events*, while recording facts. The value of stratigraphic work is not questioned, but the value of interpretation should not be underestimated. Proper interpretation of unusual events is not only difficult, but an improper interpretation may be exceedingly misleading and be conducive to error in other directions.

'The Pre-Lafayette (Tennessean) Base-level,' W J McGee, Washington, D. C.

The most extensive base-level of the North American continent is that preserved in part as an unconformity beneath the Lafayette formation, and in part as a somewhat dissected surface, extending inland from the margin of the formation. This base-level is the record of a vast period of approximate continental stability, which has been called the Tennessean.

'The Relative Ages of the Maumee Glacial Lake and the Niagara Gorge,' Chas. E. Slocum, Defiance, Ohio.

The time thought necessary for the eroding of the Niagara Gorge has been shortened by recent observers until now 7,000 to 7,500 years is believed to be sufficient. The Ice Age was probably well over before the waters began to erode the gorge. The level of Lake Erie has been little, if any, lowered by the gorge. The Maumee Glacial Lake was well drained before the Niagara River channel was worn, and the ice must have disappeared from the Lake Erie region previous to this—that is to say the Maumee Glacial Lake may have existed several thousand years before the erosion of the Niagara gorge began.

'The Galt Moraine and Associated Drainage,' F. B. Taylor, Fort Wayne, Ind.

In Canada, west of Lake Ontario, extending northeast from Paris, past Galt to Credit Forks, is about fifty miles of moraine, called the Galt moraine, and fragments of two others to the west and east. The Galt moraine in its northern part is on or close to the escarpment which runs north from Hamilton. A large river carried the glacial waters to the southwest along the front of the moraine in its early stages of formation. The bed of this river is well marked. As the ice receded the moraine was deposited, the river changed its course and for a time ran between the ice and the moraine. For several miles the bed is on the brink of the escarpment. Along that part there is no bank on the east side of the bed, but a descent of over 200 feet to the Credit river.

Further down, the river turned to the west, cut a deep channel through the moraine and joined its earlier bed at Eden Mills. In the earlier stages of the moraine the river took a southwest course from Preston past Ayr, but in the last stages a lower course was found through the moraine, longitudinally past Galt and Paris. In most of its course the flow was rapid enough to carry away most of the drift and leave the limestone ledges bare. In the broader portions it deposited cobble stones and gravel. Drumlins cover the northern part of the area in question. Further work will be necessary to show the relation between the moraines and those of western New York or those of the west side of the Ontario peninsula.

'Glacial and Modified Drift in Minneapolis, Minn.,' Warren Upham, St. Paul, Minn.

Red drift from the Lake Superior region is overlapped by bluish drift from the Red River valley and Manitoba. The final melting of the ice sheet laid bare the area occupied by glacial Lake Hamline, just east of Minneapolis, between tract of ice thus flowing from northeast and northwest. In the eastern part of Minneapolis a terminal moraine, consisting mostly of northeastern drift, was formed in the border of the western ice tract. It is evidence that the glacial current from the west pushed back that from the east, near the close of the Ice Age. The sand plain of the Mississippi Valley here was deposited near the front of the ice, when it retreated westward from this moraine, and a wide esker ridge, two miles long, formed at the same time, lies in the southwest part of the city. Frequent banding and intermingling of the red and bluish tills indicate that they were englacial.

'The Ozarkian and its Significance in Theoretic Geology,' Joseph Le Conte, Berkeley, Cal.

The name Ozarkian was coined to commemorate the erosive work in the Ozark Mountain region during a long and important epoch directly preceding the ice invasion of the Quaternary. The Ozarkian is characterized by elevation and erosion, the Glacial by ice accumulation and drift deposits, the Champlain by depression and stratified deposits. During the earth's history there have been certain well defined critical periods, characterized by great and widespread changes in the earth's crust, in its climate, or in its organic forms. They separate the primary divisions or eras of geologic time (Paleozoic, Mesozoic, Cenozoic), and such another era I am convinced is now commencing, which I have called the Psychozoic. The Quaternary period represents the critical or transition period between the Cenozoic and Psychozoic Eras, when man was *introduced*. The Ozarkian is the first epoch of this critical period. Man subsequently became *established* as the dominant factor in the earth's life history and the Psychozoic era began.

'The Discovery of New Invertebrates in the Dinosaur Beds of Wyoming,' Erwin H. Barbour and W. C. Knight, Lincoln, Nebr.

Some eight or ten new invertebrates, all apparently fresh water forms, recently discovered in the Dinosaur beds of Wyoming tend to confirm the belief that these beds are of fresh-water origin. The writer also noted about six species of lamellibranchs and gasteropods. Associated with the invertebrates are also crocodilian teeth and bones.

'The Rapid Decline of Geyser Phenomena in the Yellowstone National Park,' Erwin H. Barbour, Lincoln, Nebr.

To those who visit the geyser region frequently the rapid decline of geyser activity seems startling. From superficial observation it seems safe to assume that if the decline of activity noted during the past four years should continue for the next eight or ten years the features which most impress

the geologist will have disappeared. At the mammoth hot springs the activity is not one-tenth that of former times, Minerva Terrace having become extinct (since 1895); the discharge from Pulpit and Jupiter Terraces having greatly declined during the same period and the Narrow Gauge—a fissure vent—and other attractions, having become all but extinct. Roaring Mountain is now silent though steaming. In the Norris Geyser Basin the Black Growler is less active. In the Lower Basin the splendid Fountain Geyser is extinct, with a feeble substitute near by, called the Dewey. The Giant Paint Pots are greatly contracted in size—the pink half being extinct. In the Upper Basin some of the better known as well as many of the lesser geysers are extinct or supposed to be. Among these are the Splendid Geyser and the Beehive Geyser. The Grand Geyser, which used to erupt daily, now erupts irregularly about three times a season. The Cascade, which erupted about every quarter of an hour in 1895 now erupts once a day.

The general impression of frequenters of the Park is that the changes are serious and much more rapid than is generally believed.

'Greatest Area and Thickness of the North American Ice Sheet,' Warren Upham, St. Paul, Minn.

From the overlapping and intermingling of the drift deposits the indications are that the ice sheet at its culmination reached continuously across the continent from New England to British Columbia or southeastern Alaska, interrupted only in its southern part by the projecting ranges of the Rocky Mountains. The conclusions of Dr. G. M. Dawson that the Cordilleran glaciation mainly preceded the glaciation of the Laurentine region and of the great plains stretching westward nearly to the Rocky Mountains, and that the maximum extension of the Laurentide ice sheet was attended by a depression of the Cordilleran region, with a subsequent elevation of about 5,300 feet, is not apparently borne out by the facts. The probabilities seem to be that the Cordilleran and Laurentide ice sheets, having been each accumulated because of high continental altitude much exceeding that of the present time, were confluent along the east side of the Rocky Mountains, a continuous ice sheet at the north extending from the east to the west side of the continent.

In Minnesota and North Dakota observations on each side of the Glacial Lake Agassiz oppose the view of Tyrrell that the Laurentide ice sheet was preceded by a Keewatin ice sheet. Facts in connection with glacial lake deltas and overlapping drift deposits demonstrate contemporaneous glaciation meeting from the northwest and northeast. There is also evidence that the northwestern ice field, belonging to the Keewatin of Tyrrell, pushed back the northeastern ice field, referable to the Laurentide, showing that there the greatest extension of the Keewatin was later. From the northwest and northeast, however, the two ice fields were confluent. This great ice sheet northward, as evidenced by the height of mountain glaciation, attained a maximum thickness of one to two miles nearly across the continent, the thickness being greatest upon the Laurentide highlands.

ARTHUR HOLLICK,
COLUMBIA UNIVERSITY. *Secretary.*

SCIENTIFIC BOOKS.

Catalogus Mammalium tam viventium quam fossilium. By Dr. E. L. TROUESSART. Berlin, R. Friedländer & Sohn. New ed., fasciculus VI., Appendix and Index, 1899, 8° pp. 1265–1469. Price of complete work 66 Marks.

The completion of the great 'Catalogus Mammalium' which Dr. Trouessart has been publishing in parts during the past two years marks an epoch in systematic work in mammals. Previous catalogues, incomplete at best, have been restricted either to living or extinct forms, so that zoologists have been obliged to

consult one set and paleontologists another. But as Professor Osborn has recently remarked: "Among the vertebrates the separation of the living and extinct forms is at present a calamity. Zoologists must become familiar with paleontology whether they prefer to do so or not. It is impossible, for example, to understand the modern races of dogs without studying the Oligocene races and their ancestors."* Dr. Trouessart has sought to remedy this defect by bringing together in one list all the species of mammals, living and extinct, which have been described between 1758 (the date of publication of the 10th edition of the 'Systema Naturæ' of Linnaeus) and the close of the year 1898—a period covering exactly a century and a half.

The first three parts of this catalogue have already been reviewed in these pages;† without attempting to treat the others with the same detail, attention may be called to a few points which are suggested more especially by the last brochure. The catalogue proper consists of 5 parts containing 1,264 pages, while fasciculus VI. is devoted entirely to addenda and corrigenda (94 pp.) and a closely printed 3 column index of 109 pages.

The index has some 16,827 entries indicating that over 16,000 names have been listed; of these 2,977 are generic and 13,850 specific. The total number of recognized genera and subgenera is 1,840; of recognized species about 7,500. These numbers are significant as an index of progress in the study of mammals. In 1758, 39 genera and 183 species were described by Linnaeus; in 1798 the total number of recognized genera was less than 100 of which only 1 was extinct; while in 1898 the number of genera and subgenera recognized by Trouessart is 1,840. This rapid increase in names within the present century has resulted from the more thorough exploration of all parts of the globe, more careful study of improved material, and especially from the marvelous development in our knowledge of extinct forms.

Naturally the naming of so many species has presented many difficulties and even a superficial examination of the catalogue shows many curiosities of nomenclature. The names vary in length from one to ten syllables, the shortest being *Mus rex* and the longest *Brachydiastematotherium transsylvanicum*. The tendency to repeat favorite specific names in many groups is very noticeable; *major* has been applied to 51 species, *intermedius* to 54, *robustus* to 56, *gracilis* to 65, and *minor* to 71. Many species have been named in honor of eminent naturalists; the zoologists who have had a dozen or more mammals named after them are: Blanford, 12; Allen, Gray and Lartet each, 13; Gervais and Owen, 15; Geoffroy, 17; Gaudry, 20; Milne Edwards, 21; and Cuvier, 28.

That such a catalogue necessarily contains some errors is self-evident, but the wonder is that there are not more of them. There are of course omissions (*e. g.*, a genus, subgenus and 5 species of phyllostome bats described by Miller in the Proceedings of the Philadelphia Academy Science, in July, 1898); errors in the authority of genera and species and in the authors of papers (*e. g.*, in crediting Bailey's 'List of Mammals of the District of Columbia' to Bangs); adoption of the wrong names for groups, thus differentiating forms which are identical while reducing others to synonomy which are really distinct. But the care which the author has taken to eliminate errors of all kinds is shown by the voluminous appendix of 94 pages devoted to corrections and additions of genera and species which were omitted, or which have been described during the two years in which the catalogue has been passing through the press.

The most serious defect in the catalogue seems to be in the treatment of genera. References are so seldom given that it is difficult to consult the original descriptions. Moreover the 2,977 generic names indexed probably do not represent much more than 65 per cent. of those actually published, so that in some cases names which have the best claim to adoption are not even mentioned. It should be stated that the author's aim has been to adopt the best known or most generally used name for a genus, on the plea that the work would thus be more generally useful—in short he has in many cases followed the *auctorum plurimorum* rule rather than the law of priority. He has thus been led to

*Science, N. S., X., p. 171, August 11, 1899.

†Science, N. S., VI., pp. 68-69, July 9, 1897; VII., pp. 30-33, January 7, 1898.

adopt some names which are preoccupied, but in this respect there is a marked improvement in the latter part of the catalogue. The selection of the best known designation, regardless of whether the name is preoccupied or antedated, is likely to lead to more trouble than convenience in the long run. Changes in names are always objectionable, particularly in higher groups, but it is safe to say that nearly 5 per cent. of all the genera and subgenera in this catalogue are likely to undergo change within a few years. Dr. Trouessart might have prevented much trouble for students in future by making the changes now demanded by the law of priority. Even if he preferred to adopt the other course in the body of the list, a table might have been inserted in the appendix showing the earliest names of groups for which he had selected the best known designation, but even this seems to have been impracticable on account of the undue length of the appendix.

Without attempting to give such a table here, it will suffice to illustrate this point by mentioning 50 genera and subgenera which have not been corrected in the appendix. It should be explained, however, that these do not by any means include all the names which rest on an unstable basis. Full references are added, as some of the genera are not given in the catalogue, although the majority of them are mentioned in synonymy with merely authorities and dates.

Page 4. For *Siamanga*, 1843—substitute **Symphalangus** Gloger, Hand- u. Hilfsb. Naturgesch., I., p. 34, 1841.

P. 44. For *Brachyurus*,* 1823—**Cacajao** Lesson, Species des Mamm., pp. 181–183, 1840.

* Trouessart's *Brachyurus* contains two subgenera: A, *Ouakaria* Gray, 1849 and B, *Brachyurus*. Since *Brachyurus* Spix, 1823, is preoccupied by *Brachyurus* Fischer, 1813, a group of field mice, the genus becomes *Cacajao* Lesson, 1840, and subgenus A, *Ouakaria* also becomes *Cacajao* both being based on *Simia melanocephala*. Subgenus B, *Brachyurus* including the redfaced species, if really worthy of separation, apparently requires a new name and may be called *Cothurus* (docked tail). *Ouakaria* is not available for this group as it has already been restricted to the blackheaded forms and *Cercoptochus* Gloger, 1841, based on the uakaris in general, must be restricted to the same group since it was proposed before any of the redfaced species had been described.

P. 44. For subgenus *Brachyurus* Trouessart—**Cothurus** nom. nov. Type *Brachyurus calvus* Geoff.

P. 46. For *Chrysothrix*, 1835—**Saimiri** Voigt, Cuvier's Thierreich, I., p. 95, 1831.

P. 47. For *Nyctipithecus*, 1823—**Aotus** Humbolt, Recueil Obs. Zool. Anat. Comp., I., pp. 306–311, 358, 1811.

P. 62. For *Cheiromys*, 1799—**Daubentonia** Geoffroy, Décad. Philos., IV., p. 193, 1795.

P. 66. For *Hemigalago*, 1857—**Galagoides** Smith, S. Afr. Quart. Journ., 2d ser., II., p. 32, 1833.

P. 84. For *Cynonycteris*, 1852—**Rousettus** Gray, London Med. Repos., XV., p. 299, 1821.

P. 90. For *Megaloglossus*,* 1885—**Trygenycteris** Lydekker, in Flower & Lydekker's, Mamm. Living & Extinct, p. 655, 1891.

P. 135. For *Furia*,* 1828—**Furipterus** Bonaparte, Icon. Fauna Italica, I., fasc. XXI. (under *Plecotus auritus*), 1837.

P. 149. For *Mystacina*,* 1843—**Mystacops** Lydekker, in Flower & Lydekker's, Mamm., Living & Extinct, p. 671, 1891.

P. 152. For *Macrotus*,* 1843—**Otopterus** Lydekker, in Flower & Lydekker's, Mamm., Living & Extinct, p. 673, 1891.

P. 153. For *Lophostoma*, 1838—**Tonatia** Gray, Griffith's Cuvier, Anim. Kingdom, V., p. 71, footnote, 1827.

P. 155. *Tylostoma*,* 1855—**Anthorhina** Lydekker, in Flower & Lydekker's, Mamm., Living & Extinct, p. 674, 1891.

P. 156. For *Carollia*,* 1838—**Hemiderma** Gervais, Expéd. Comte de Castelnau l'Am. du Sud, Mamm., p. 43, 1855.

P. 158. For *Ischnoglossa*,* 1860—**Leptonycteris** Lydekker, in Flower & Lydekker's, Mamm. Living & Extinct, p. 674, 1891.

P. 203. For *Mygale*, 1800—**Desmana** Güldenstädt, Beschäft. Berliner Gesellsch. Naturf. Freunde, III., p. 108, 1777.

P. 212. For *Centetes*, 1811—**Tenrec** Lacépède, Buffon's Hist. Nat., Didot ed., Quad., XIV., p. 156, 1799.

P. 248. For *Cercoleptes*, 1811—**Potos** Cuvier & Geoff., Mag. Encyclopédique, II., p. 187, 1795.

P. 287. For *Enhydra*,* 1822—**Latax** Gloger,

* Preoccupied.

Nova Acta Acad. Cæs. Leop.—Carol., XIII., pt. 2, p. 511, 1827.

P. 297. For *Hypotemnodon*, 1894—**Mesocyon** Scott, Princeton College Bull., II., p. 38, 1890.

P. 341. For *Hemigalidia*, 1882 — **Salanoia**, Gray, Proc. Zool. Soc. London, pp. 523–524, 1864.

P. 372. For *Callorhinus*,* 1859—**Callotaria** Palmer, Proc. Biol. Soc. Wash., VII., p. 156, 1892.

P. 375. For *Trichechus*,* 1766—**Odobenus** Brisson, Regnum Anim., 2d ed., pp. 12, 30–31, 1762.

P. 377. For *Macrorhinus*,* 1826—**Mirounga** Gray, Griffith's Cuvier, Anim. Kingdom, V., pp. 179–181, 1827.

P. 380. For *Ogmorhinus*, 1875—**Hydrurga** Gistel, Naturgesch. Thierreichs, p. XI., 1848.

P. 421. For *Macroxus*, 1823—**Guerlinguetus** Gray, London Med. Repos., XV., p. 304, 1821.

P. 453. For *Myoxus*, 1780 — **Glis** Brisson, Regn. Anim., 2d ed., pp. 13, 113–118, 1762.

P. 724. For *Euprotogonia*, Apr. 1893—**Tetraclænodon** Scott, Proc. Acad. Nat. Sci., Phila., Nov. 1892, pp. 299–300.

P. 754. For *Ceratorhinus*, 1867—**Didermocerus**† Brookes, Cat. Anat. and Zool. Museum, p. 75, 1828.

P. 817. For *Dicotyles*, 1817 — **Tayassu** G. Fischer, Zoognosia, III., pp. 284–289, 1814.

P. 835. For *Oreodon*,* 1851—**Merycoidodon** Leidy, Proc. Acad. Nat. Sci., Phila., pp. 47–50, 1848.

P. 896. For *Furcifer*,* 1844—**Hippocamelus** Leuckart, De Equo bisulco Molinæ, p. 24, 1816.

P. 950. For *Hippotragus*, 1846 — **Ozanna** Reichenbach, Vollst. Naturgesch. In- u. Auslandes, Säugeth., III., pp. 126–131, 1845.

P. 967. For *Aploceros*, 1827—**Oreamnos** Rafinesque, Am. Monthly Mag., II., p. 44, 1817.

P. 1000. For *Manatus*, 1772—**Trichechus** Linnæus, Syst. Nat., ed. 10, I., p. 34, 1758.

P. 1003. For *Eotherium*,* 1875—**Eotheroides** nom. nov. *Eotherium* Owen is preoccupied by *Eotherium* Leidy, 1853, a genus of Perissodactyla.

* Preoccupied.

† If this name is considered invalid because published in a sale catalogue, the subgenus stands *Dicerorhinus* Gloger, 1841.

P. 1007. For *Halicore*, 1811—**Dugong** Lacépède, in Buffon's Hist. Nat., Didot ed., Quad., XIV., p. 193, 1799.

P. 1008. For *Rhytina*, 1811—**Hydrodamalis** Retzius, Kongl. Vet. Acad. nya Handl., Stockholm, XV., p. 292, 1794.

P. 1009. For *Zeuglodon*, 1839—**Basilosaurus** Harlan, Trans. Am. Philos. Soc., new ser., IV., pp. 397–403, 1834.

P. 1016. For *Argyrodelphis*, Apr., 1894—**Diochotichus** Ameghino, Énum. Syn. Mamm. Foss. Eocène Patagonie, p. 182, Fev. 1894.

P. 1017. For *Pontistes*, 1885—**Palaeopontoporia** Doering, Exped. Rio Negro (Patagonia), III., Geol., pp. 437, 455, 1882.

P. 1037. For *Tursio*,* 1830—**Lissodelphis** Gloger, Hand- u. Hilfsbuch Naturgesch., I., p. 169, 1841.

P. 1042. For *Neomeris*,* 1846—**Neophocæna** Palmer, Proc. Biol. Soc. Wash., XIII., p. 23, Jan., 1899.

P. 1048. For *Orca*,* 1846 — **Orcinus** Fitzinger, Wiss.- pop. Naturgesch. Säugeth, VI., pp. 204–217, 1860.

P. 1120. For *Tamandua*,† 1842—**Uroleptes** Wagler, Nat. Syst. d. Amphibien, p. 36, 1830.

P. 1121. For *Cyclothurus*,† 1842—**Cyclopes** Gray, London Med. Repos., XV., p. 305, 1821.

P. 1146. For *Lysiurus*, 1891 — **Cabassous** McMurtrie, Cuvier's Anim. Kingdom, I., p. 164, 1831.

P. 1261. For *Echidna*,* 1798—**Tachyglossus** Illiger, Prod. Syst. Mamm. Avium, p. 114, 1811.

P. 1263. For *Proechidna*, Nov., 1877 — **Zaglossus** Gill, Ann. Record Sci. & Industry for 1876, p. CLXXI., May, 1877.

This list of exceptions to the generic names which Dr. Trouessart has adopted should not be considered as a reflection on the value of his work. Its main object is to illustrate the author's method of selecting names and to call attention to some of the earliest ones which do not happen to be now in common use. It has been prepared to increase, if possible, the usefulness of the work rather than to detract from it.

So far as species are concerned the catalogue is evidently much more complete, although, as

* Preoccupied.

† Usually quoted as 1825, but in reality a *nomen nudum* previous to 1842.

pointed out above, there are a few omissions. There is, of course, room for diversity of opinion concerning the validity of some of the species which are given recognition, but no one can be personally familiar with the characters, history and synonomy of such a multitude of forms, and all that the author could do was to take the latest revision of each group as his guide. In adopting this course he has done all that could be expected and has produced a valuable *résumé* of the labors of specialists in many groups.

In fact, too much can hardly be said in favor of the catalogue. It represents an enormous amount of painstaking labor and will long remain a monument to the industry, patience and bibliographical skill of its author. It is indispensable to the student of mammals and its chief drawback is, perhaps, its high price (66 Marks), which may put the book beyond the reach of some who need it most.

T. S. PALMER.

WASHINGTON, D. C.

The Genera and Species of Blastoidea, with a list of the Specimens in the British Museum of Natural History. By F. A. BATHER. London. 1899. 8vo. Pp. x + 70.

This list "attempts to provide a complete index to every name that has ever been applied to a real or supposed Blastoid genus or species." It also gives the names now considered valid, and the synonyms with 'cross-references from the latter to the former.' It cites the literature, "the bibliographic details being placed under the name now valid. It catalogues all the specimens of Blastoidea contained in the Geological Department of the British Museum," and designates the specimens of historical interest, the types and figured specimens.

Bather's catalogue, like all of his work, is very detailed. The bibliographic references are not always mere title citations, but often give the important conclusions of writers, particularly those of synonymy. The list, however, 'is in no sense a revision' of the Blastoidea.

The important change in this list is the retention of *Nucleocrinus*, Conrad, 1842, in place of *Elæacrinus*, Roemer, 1851. *Orbitremites*, a nomen nudum of Gray, 1840, was established by T. & T. Austin, 1842, and, therefore, displaces *Granatocrinites*, Troost, 1849 (nom. nud.), *Granatocrinus*, Hall, 1862, and Etheridge and Carpenter, 1886. *Orophocrinus*, von Seebach, 1864, although in general use, should be displaced by *Dimorphicrinus*, d'Orbigny, 1849. Bather does not make this change, although he disapproves of Etheridge's and Carpenter's reason for rejecting this name, namely, *Dimorphicrinus*, "has never been adopted by paleontologists on account of the erroneous and incomplete nature of his generic diagnosis." On the same ground other names now in use can be rejected. The reviewer prefers to accept *Dimorphicrinus*.

The total number of specimens of Blastoidea in the British Museum is 1,223, representing 73 species out of a total of about 166 listed species. "These figures speak for themselves. However numerous may be the specimens of Blastoidea in other museums, there can scarcely be any collection so representative of the class as a whole, or so rich in specimens of the highest scientific importance, as in that of the British Museum."

CHARLES SCHUCHERT.

U. S. NATIONAL MUSEUM.

Grundlinien der Maritimen Meteorologie. Von PROFESSOR DR. W. KÖPPEN, Abtheilungs-Vorsteher an der Deutschen Seewarte. Hamburg, Verlag von G. W. Neumayer Nachfolger. 1899. 8vo. Pp. vi + 88.

There has for some time been need of just such a book as Dr. Köppen has now given us. We have a brief and elementary presentation of the fundamental principles of marine meteorology, arranged by a master of the subject, in attractive form. While the book is intended especially for seamen, and as an introduction to the more advanced *Segelhandbücher* of the German Naval Observatory at Hamburg, students of meteorology in general will find it admirably suited to their own use. There are six chapters, the subjects of which are as follows: I., instruments; II., the correlation of the weather elements; III., the periodic variations of temperature, pressure, etc.; IV., the geographic distribution of weather phenomena,

and the climates of the earth's surface; V., the difficulties in the way of navigation due to storms, head winds, calms and fog; VI., the movements of the ocean, viz., waves and tides. Of these chapters the fifth seems to us perhaps the most generally useful in the book. It deals with the nature, seasons, tracks and characteristics of cyclones in the different oceans, and the rules for navigating when in the vicinity of a cyclone. The relation of the prevailing winds and calm belts to various sailing routes are clearly presented, and the prevalence of fog in different regions is briefly discussed.

In connection with the sailing directions, Köppen makes use of an ingenious device, modelled after Piddington's famous transparent storm cards in his classic 'Sailors' Horn Book for the Law of Storms.' Köppen's storm card consists of a transparent sheet of paper, on which are three figures. The first shows the winds around a cyclone in the Northern Hemisphere; the second shows the winds around an anticyclone in the Northern Hemisphere; and the third shows the characteristic isobaric types and accompanying wind changes during the easterly movement of ordinary weather conditions. By turning the transparent paper over, the same diagrams serve for the Southern Hemisphere.

Such a book as Köppen's *Grundlinien der Maritimen Meteorologie* should be translated into English, and it is to be hoped that the author will arrange to have an English edition published shortly.

R. DeC. Ward.

Descriptive General Chemistry. By S. E. Tillman, Professor in the U. S. Military Academy. New York, John Wiley & Sons. 1899. 2d Ed., p. 429.

This new aspirant for chemical honors has been written mainly for the use of the cadets of the U. S. Military Academy. In the language of the author "it has generally been the conclusion of those charged with this instruction at the Academy in the past that the laboratory method alone, or mainly, in so short a course, could not be made of as much value to the pupils as the method of making the *acquisition of knowledge* the essential feature, and that the best results could be reached through careful study of the proper text, well-conducted recitations, accompanied by experimental and explanatory lectures." Accordingly "this book has been prepared to embody the substance and arrangement of a short chemical course for the *general* student. It aims to give a concise statement of the more fundamental principles of chemistry, together with that class of chemical information most essential to cultured men, and which will enable them to comprehend many ordinary natural phenomena, as well as to understand the more important applications of the science which are now so frequently met with. The book is not fitted nor intended for laboratory guidance."

It is an interesting production and merits high praise and a cordial reception from all interested in the promulgation of chemical science.

Edgar F. Smith.

Elementary Studies in Chemistry. By Joseph Torrey, Jr., Harvard University. New York, Henry Holt & Co. 1899. Pp. 487.

Nearly every teacher of chemistry in time feels that even the best text-books which have been prepared are not just exactly what he desires. He is imbued with the idea that what he wishes the student to derive from a course of chemical instruction can be better obtained by some other method or plan than any previously proposed. In other words, he wishes to reach the goal in his own peculiar way. He knows what that goal represents, how he reached it, and is firmly convinced that by his method those placed in his charge can also gain it. The usual result of this reasoning is eventually a new book on chemistry. The author of the present volume, 'dedicated to my students, past and present,' has doubtless had his own experience in getting young men to profit by careful drill in chemical experimentation, etc., and in this new contribution outlines his method of instruction.

The reviewer has had great pleasure in following the different steps of the development, and is happy to add that in his humble judgment, Mr. Torrey has prepared a most valuable student guide, and deserves the congratulations of both students and teachers of the science.

Edgar F. Smith.

BOOKS RECEIVED.

Einfuhrung in die Chemie in leichfassliche Form. LASSAR-COHN. Hamburg and Leipzig, Leopold Voss. 1899. Pp. xii + 299. M. 4.

Qualitative Analysis for Secondary Schools. CYRUS W. IRISH. New York, Cincinnati and Chicago, American Book Co. 1899. Pp. 99.

Laboratory Exercises, with Outlines for the Study of Chemistry. H. H. NICHOLSON and SAMUEL AVERY. New York, Henry Holt & Co. 1899. Pp. vi + 134. 60 cents.

The Hygiene of Transmissible Diseases. A. C. ABBOTT. Philadelphia, W. B. Saunders. 1899. Pp. 311.

SCIENTIFIC JOURNALS AND ARTICLES.

The American Naturalist for September opens with 'A Contribution to the Life History of Autodax lugubris Hallow,' by Wm. E. Ritter and Loye Miller, followed by an account of 'The Worcester Natural History Society,' by Herbert D. Braman. The third of the very useful 'Synopses of North American Invertebrates,' is by J. S. Kingsley and deals with the Caridea; and N. R. Harrington who this summer sacrificed his life in order to study Polypterus, contributes a valuable article on its life habits. The 'Pads on the Palm and Sole of the Human Fœtus' are discussed by R. H. Johnson who considers them homologous with the walking pads of some mammals. Among the topics discussed by the editor is that of 'New Species,' many of which are considered to be founded on very trivial characters.

DISCUSSION AND CORRESPONDENCE.

NATURALISM AND PHILOSOPHY.

"Had men in the discoveries of the natural world, done as they have in the intellectual world, involved all in the obscurity of doubtful and uncertain ways of talking, volumes writ of navigation and voyages, theories and stories of zones and tides, multiplied and disputed, nay, ships built and fleets sent out, would never have been taught us the way beyond the line, and the antipodes would still be as much unknown as when it was declared heresy to hold there were any."

IN a discussion, in the current number of SCIENCE of my criticism of Ward's *Naturalism and Agnosticism*, it is intimated that my 'harshness' may, perhaps, be due to irritation by Ward's castigation of Spencer. I therefore wish to say that I read this with interest and sympathy, and found it by far the most valuable part of the book; but as Ward's method of treating the Synthetic Philosophy is an old story to zoologists, I saw no reason to review it for readers of SCIENCE.

As I understand Ward's reasoning on this subject, I fully agree with it, and should myself put it in these words: It is not by generalization and abstraction, but by discovery, that knowledge is advanced; but the first principles of this philosophy are based upon abstraction and generalization and can add nothing to knowledge.

Zoologists have long been aware that they who, in past generations, sought to advance our knowledge of living things by generalizing them, or referring them to genera, hindered the progress of zoology, which began to advance with rapid strides as soon as naturalists perceived that our only source of knowledge of living things is the study of the living things themselves. So far as it concerns the zoologist, Ward's method of handling the works of the author of 'The Principles of Biology' is ancient history—a record of a fight that was fought out fifty years ago.

Passing, then, to another topic, I ask space for a few quotations which seem to have a bearing upon the assertion by my critic that Ward's book is 'wrought out in sympathy with scientific methods.'

Ward says, II., 44.—"Granted that we are only entitled to say that the dice actually do fall, when they are thrown from the box, not that they must fall; granted that we may only say that their after course *is* entirely and absolutely the result of the initial conditions, not that it must be; still this is enough. * * * On the naturalistic assumption * * * matter and energy are indestructible and ingenerable, and the laws of their working rigorous, exact and unalterable."

It is not the naturalist, but the philosopher, who asserts that the dice *will* fall. The naturalist expects them to fall, but expectation, however well founded and reasonable, is not fatalism. Naturalism knows nothing of determinism. It does not assert that the after course of the

dice *is inevitably and absolutely the result of the initial conditions.* This is the teaching of philosophers. What the naturalist asserts is that the 'initial conditions' are signs which mean that he may expect the dice fall. So far as his scanty and imperfect knowledge of nature extends, all dice thus placed have thus fallen, and he has reasonable confidence—confidence so reasonable in this case that we call it moral certainty—that dice will continue so to do, since the after course of all the dice he has thrown has been neither more nor less than what the initial conditions would have led one to expect.

Ward says that he has tried, in his first lecture, to present "an outline sketch of that polity of many mansions, which we may call the Kingdom of the Sciences, and the mental atmosphere in which its citizens live"; but the mental atmosphere which is here presented is one in which few of these citizens would care to pass their lives, however wholesome the philosophers may find it.

Thus we are told, P. 13—"as to material phenomena, certain mechanical laws are held to be supreme; that a single atom should deviate from its predetermined course were as much a miracle as if Jupiter should break away from its orbit and set the whole system in commotion."

So far as I understand the mental atmosphere of the men of science, and may be permitted to speak for them, they assert that nothing can deviate from natural law, since nature is neither more nor less than that which is.

Scientific law involves no notion of supremacy, since it is nothing more than a statement of observed facts, joined to reasonable confidence—confidence which is more or less reasonable according to knowledge—what we may expect under certain conditions. As Berkeley has expressed it, natural laws are "general rules, which teach us how to act and what to expect."

To Ward's question, II., 85.—How we "know that the whole sidereal system will not turn out more like the bird than the stone; an organized whole manifesting life and self-direction?" he answers that he does not know anything of the sort. If Jupiter should *break away* from his orbit, and *set* the whole system in commotion, the true naturalist would assert, not with regret or disappointment, but with hearty satisfaction, that he knows more about celestial mechanics than he did before, and that he will now, if he has opportunity, study Jupiter's motives and his cerebral pathology, and try to find out what to expect from a planet so erratic. It is not he, but the philosophers, who teach that events which are mechanical are predetermined, although he does assert that he fails to see what good can come from an attempt to find out Jupiter's motives until he does begin to break things and to behave in a way which astronomers had no reason to expect.

Ward tells, II., 48.—that as the naturalists conceive the world as a whole "it seems comparable to nothing so much as an upturned hour glass. The glass could not start itself; this, at least, was an interference from without, but it was an interference before the process, not during it. Science, which is confined to describing the movements of the sand, can give no account of this catastrophe, and no meaning to it. But once the glass is turned the downward dance of the last grain to move is just as inevitable as that of the first; and the several movements being fixed, any collateral consequences of them must be taken as fixed, too."

The naturalist does *not* know that the 'downward dance' of the first grain to move is inevitable. He asserts that he has good reason to expect and no reason to doubt that the sand will run. If it should do anything else, in the absence of an obstruction, he would know more than he does now, and he would try to find out why his expectations have disappointed him.

He asserts, furthermore, that he may find meaning in the turning of the glass, provided he knows what Ward himself calls the 'initial conditions'; that he has good reason to believe that some one turned it because he chose.

He also has good reason to believe that, if he had known these initial conditions, the desire to turn the glass, and the turning of the glass, would be neither less nor more than he might have expected.

The interminable controversy about deter-

minism and free will does not exist for the naturalist—not because he doubts his freedom and responsibility, but because he knows nothing of determinism.

We cannot be surprised that some students of science should confuse their reasonable expectations that the future will, on the whole, be essentially like the past with belief that it must so be, when we remember how often they have been told by philosophers like Ward that the scientific conception of the mechanism of nature is the conception of 'an unbroken and unbreakable mechanism,' which 'absolutely determines' the order of events, and 'banishes spirit and spontaneity,' 'holding all things fast in fate'; although most men of science are now as emphatic as Berkeley in the declaration that naturalism means nothing of the sort. What they assert that it does mean is that we know nothing of 'catastrophes.' As Sir Thomas Browne tells us: "It was the ignorance of man's nature that begat this very name, and by a careless term miscalled the providence of God; for there is no liberty for causes to operate in a loose or careless way."

W. K. BROOKS.

JOHNS HOPKINS UNIVERSITY.

MEDICAL SCIENCES IN THE UNIVERSITY.

TO THE EDITOR OF SCIENCE.—Permit me to call attention to a somewhat inaccurate statement made by Professor Minot in his very interesting address delivered at the Medical Commencement of Yale University and subsequently published in SCIENCE. Professor Minot says: "If a young man wishes to make a scientific career, if his interest is chemistry, physics, botany or zoology, he is received at one of our universities started upon a well-planned course properly systematized, he gives for two or three years most of his strength to his main subject, but he follows probably two cognate subjects as minor studies, and at the end of his time, if successful in his work, he receives a degree, which attests his proficiency in his special science. Should the same young man elect to study one of the medical sciences, physiology, pathology or bacteriology, no university will give him corresponding recognition. The utmost he can find is opportunity for advanced work in his special subject, but with no university guidance, no plan of correlated studies, and he can look forward to no degree, nor even to a certificate from the university."

In this University, from its foundation in 1876, physiology has been given complete university standing. Its courses are coördinate in every way with those in chemistry, physics, botany or zoology, and many students have offered it, after three or more years of continuous study, as a major subject for the degree of Doctor of Philosophy. The same may be said with regard to pathology and bacteriology.

I speak only for the Johns Hopkins University, but there are other universities in this country in which physiology is also accorded every privilege in the philosophical faculty.

W. H. HOWELL.

JOHNS HOPKINS UNIVERSITY, BALTIMORE, MD.
September 28, 1899.

NOTES ON INORGANIC CHEMISTRY.

OWING to the difficulties in the way of using acetylene on a large scale as an illuminant, and in part perhaps also owing to the opposition raised by those interested in other methods of lighting, the new illuminant has not made the rapid progress predicted for it. Some towns on the continent of Europe, however, have adopted it, as the town of Veszprim in Hungary, and in a recent number of the *Chemiker Zeitung*, Professor J. Vértess gives a paper on some of the drawbacks which attend the use of acetylene. In the first place the calcium carbid from which it is generated is in commerce never pure, but contains at least 20 per cent. of impurities. Theoretically, 350 liters acetylene per kilo carbid should be obtained, but as a matter of fact in practice hardly more than 280 or 290 liters can be depended upon. Again, the carbid contains sulfur, phosphorus and nitrogen, so that we have as impurities in the acetylene, hydrogen sulfid, phosphin and ammonia; hence it follows that acetylene must be purified in much the same way as ordinary coal gas. While burning from an ordinary burner, after a time the flame becomes smoky and carbon is deposited on the burners. This seems to be owing to the burner attaining a temperature higher than that of the decomposition of acetylene. Vértess also

calls attention to another drawback, in occasional fog formed in a closed room where acetylene is used. This he thinks is due to the deposition of carbon as the hydrogen of the acetylene burns, thus creating a sort of mist. It will require some ingenuity to overcome all these difficulties, but we cannot doubt but that it will be accomplished in the near future; as it is, the progress of acetylene has advanced much more rapidly than any other form of artificial illumination.

The most serious problem in the generation of acetylene on a small scale is the after-formation of gas in the generator. This is discussed by P. Wolff in the *Metallarbeiter*, and reproduced in the *Chemical News*. According to Wolff this after-generation is due to three causes: the action of the residual water contained in the pores of the carbid, the condensation of water on the surface of the carbid, and the absorption of aqueous vapor. In an experiment where the carbid reservoir was over petroleum, the after-generation was 6 liters in 24 hours, 16 liters in three days and remained constant at this figure. Over water 25 liters were given off in one day, and 30 liters in three days. The generation of gas continued at five to six liters a day until the carbid in the generator was completely decomposed. This shows the danger in small generators where there can be no large reservoir. In large apparatus a gas reservoir can be attached which will have capacity to hold this generated gas and that without compression, which would render it dangerous. The best device is spoken of as being that of Münsterberg, which not only has a relatively large reservoir, but a device for closing the carbid chamber by an air-tight valve which completely shuts off the chamber when the apparatus is not in use. No mention is made of the device which has been used in this country, where the carbid is dropped in small lumps into water. As each piece is exhausted a new portion is fed automatically.

Professor R. Stavenhagen, of Berlin, has described in the *Berichte* the properties of tungsten, which have been, heretofore, only imperfectly studied in impure specimens of the metal. The tungsten was obtained by reduction of the oxide by aluminum. It is found to be practically insoluble in acids, even in aqua regia; it dissolves slowly, however, in fused caustic potash. It is decidedly hard, of a color slightly darker than that of zinc, and is infusible in the electric arc.

According to the *Chemical News* of August 18th, Professor Dewar, at the Royal Institution, had just succeeded in obtaining hydrogen as a solid, glassy, transparent mass. Further particulars of this interesting discovery will be eagerly looked forward to.

J. L. H.

THE NEW COLLEGE PRESIDENTS.

On this subject the *Educational Review* for September comments editorially as follows:

"Four of the most important college presidencies to which we made reference some time ago have been filled, and so satisfactorily filled that it is a matter for rejoicing. It seems to us that Presidents Hadley of Yale, Harris of Amherst, Faunce of Brown, and Wheeler of California were the best selections possible, taking into account the peculiar traditions and problems of each of the four institutions and the personal equation of the man chosen to preside, we hope for at least a quarter of a century, over the teaching body of each. Three of the four men are successful and experienced teachers, and the fourth is a clergyman whose teaching instinct is very strong and whose relations to education have been very close. In these elections the recently exploited newspaper theory that a large college needs a business man or a money getter for President has received a set-back and a severe rebuke. We can imagine few things worse for higher education in the United States than to have the spirit of commercial trading and the business man's point of view obtain strong foothold in it. 'Business methods' have debauched and are debauching politics on every hand, and the treasure house of education must be protected from their inroads at all hazards. The idealism which American life so sorely needs must be furnished in large part by the universities, and the two last questions for their governing boards to be taught to ask are, Is it 'timely'? and, Will it pay?

"Moreover, the typical business man cannot, in the nature of the case, be successful in such a post. His standards of success are the reverse of educational. Underneath the temporary appearance of external prosperity which such a president might bring, there is almost certain to be the dry rot of educational neglect. The more important the college or university, the more surely it needs expert educational supervision. For this there is no possible substitute. Like a city school system, a college or university needs someone in its administration who knows and understands its educational activity in every part, who can distinguish real teaching from sham teaching, and the force of whose personal inspiration will be felt in every department. Those who remember the administration of President McCosh of Princeton, well understand what this means.

"The four new presidents are men of this type. They are men of strong personality, and each will leave his mark for good upon the institution which has honored him. All four are, in a large sense, men of affairs, and may be expected to relate their institutions more closely than ever to the life and thought of the time. This new impulse is particularly needed at Yale, where what we believe to be an unfortunate and dangerous policy of educational isolation has long been pursued. To overcome that isolation, and to restore Yale to its legitimate place as a progressive educational influence are likely to be two of the most noteworthy achievements of President Hadley's administration."

THE PROTECTION OF BIRDS.

THE Commissioner of Education, of the Public Schools, of the State of Rhode Island, Thos. B. Stockwell, has issued the following circular:

TO THE SCHOOL OFFICERS AND TEACHERS OF THE STATE OF RHODE ISLAND:

I desire to call your attention to the efforts now being made in this State by the Audubon Society for the preservation of our native birds. From reliable statistics it is evident that unless some active measures are speedily taken, their number will be very much reduced and some varieties will become extinct.

The value of the birds, from various points of view, is incalculable. As a protection to the farmer against the ravages of countless forms of insect life, as a source of joy and satisfaction to every lover of nature, they minister both to our material and our æsthetic interest. Indeed, it was not till within a few years that the Department of Agriculture, through a long course of accurate observations, determined beyond a question the economic value of almost every native bird in his relation to the various forms of vegetation; and it is no longer debatable whether the inroads of certain pests destructive to certain forms of vegetation are not due quite largely to the scarcity of the birds.

As any improvement in this matter must be brought by imparting more correct information about the birds, it is evident that the public schools, and especially those of the country sections, afford the most effective means for the dissemination of the facts, and the awakening of a life interest in the protection of bird life. The new movement towards Nature Study, which has recently been manifested and is spreading quite rapidly through the schools, furnishes the natural channel by means of which instruction and information on this subject may be readily brought before the children, and through them to the people generally.

The more our children are brought into the right touch with nature, and especially with such beautiful creatures as the birds, the more certain it is that their minds and hearts will be filled with right sentiments and feelings, and that their characters will be moulded aright.

To that end then I bespeak your cordial interest in this general subject, and your coöperation with the plans of the Audobon Society for the protection of our feathered friends.

THE COMPANIONS OF POLARIS.

PROFESSOR W. W. CAMPBELL, of Lick Observatory has made the following statement in regard to his discovery that Polaris or the North Star is a triple system:

The observations of Polaris were made with the Mill's spectroscope attached to the thirty-six-inch telescope. From the well-known principle of the shifting of the lines in the spectrum of a star, we can determine whether the star is approaching or receding from the observers and how rapidly. For most stars the velocity is constant. For some stars the velocity is variable, due to the attractions of companion stars.

The recent observations of Polaris at Lick Observatory show that its velocity is variable. It is approaching the solar system now with a

velocity of eight kilometers per second. This will increase in two days to fourteen kilometers, and in the next two days will decrease again to eight kilometers. This cycle of change is repeated every four days. The bright Polaris, therefore, revolves about the centre of gravity of itself and its invisible companion once in four days. The orbit is nearly circular and is comparable in size with the moon's orbit around the earth.

This centre of gravity, and therefore the binary system, is approaching the solar system at present with a velocity of eleven and a half kilometers per second. A few measures of the velocity of Polaris made here in 1896 gave its approach at the rate of twenty kilometers per second. Part of this change since 1896 could be due to a change in position of the orbits of the binary system, but most of it must have been produced by the attraction of a third body on the two bodies comprising the four-day system. The period of revolution of the binary system around the centre of gravity of itself and the third body is not known, but is probably many years.

Both companions of Polaris are invisible, but their presence is proved by disturbances which their attractions produce in the motion of the bright Polaris.

SCIENTIFIC NOTES AND NEWS.

THE British Association for the Advancement of Science has held a successful meeting at Dover. We publish this week the address of the president, Sir Michael Foster, and hope to be able to publish shortly some account of the meeting and several of the addresses given by the presidents of the sections.

THE International Geographical Congress began its meeting at Berlin on September 27th, with about 1200 members in attendance. Baron von Richthofen presided, Prince von Hohenlohe, the imperial Chancellor being the honorary president. The sections were as follows: (1) mathematical geography, geodesy, cartography, geophysics; (2) physical geography (geomorphology, oceanology, climatology); (3) biological geography; (4) industrial and commercial geography; (5) ethnology; (6) topical geography, exploring travels; (7) history of geography and of cartography; (8) methodology' school geography, bibliography, orthography of geographical names. Among the Americans in attendance were General A. W. Greely, of the U. S. Signal Service, Professor W. M. Davis, of Harvard University, and Mr. A. L. Rotch of the Blue Hill Observatory.

IT has been decided that the Zoological Park of New York will be opened to the public either on October 18th or October 25th.

THE commission from the Johns Hopkins University, under the direction of Dr. Simon Flexner, has returned from Manila where the summer has been spent in the study of tropical diseases.

MR. WALTER WELLMAN arrived in London on August 28th and gave at the British Association an account of his Polar expedition. He sailed for New York on September 30th.

THE freedom of the borough of Carnarvon was conferred upon Sir W. H. Preece, the eminent engineer, on September 21st. He was also presented by the Town Council with a silver casket and entertained at a banquet.

DR. ANTON FRITSCH, director of the zoological and paleontological collections of the museum at Prag, has published in a local paper an account of his recent visit to America. He speaks in high praise of the museums, institutions and collections, and recommends younger men of science to follow his example and visit the scientific institutions of the United States.

DR. GEORGE A. HENDRICKS, professor of anatomy in the College of Medicine and Surgery of the University of Minnesota, died in Minneapolis on September 24th.

SIGNOR MARCONI has been able to report successfully by wireless telegraphy the international yacht races. The messages were sent from the steamship *Ponce* to a station at Navesink Highlands.

A TELEGRAM has been received at the Harvard College Observatory from Professor Krentz at Kiel Observatory, stating that a comet was discovered by Gacobini at Nice, Sept. 29, 313 Greenwich Mean Time, in R. A. $16^h\ 26^m\ 32^s$ and Dec. $-5°\ 10'$.

Daily motion in R. A. $+2^m\ 0^s$
Daily motion in Dec. $+0°\ 10'$.

WE learn from the *Botanical Gazette* that Dr. Henry C. Cowles of the University of Chicago has spent several weeks with a party of advanced students at Marquette, Mich., prosecuting ecological studies on the adjacent flora.

THE executors of the late Professor O. C. Marsh, of Yale University, will sell for the benefit of the University his valuable collection of orchids, objects of art, antiques, etc. The sale will take place during the present month but the exact date is not yet fixed.

THE first meeting of the International Congress of Life-Assurance will be held in Brussels from September 25th to the 28th.

THE American Institute of Mining Engineers held last week its annual meeting in San Francisco. At the adjournment a two weeks' visit through the mining regions of the State was begun.

THE tenth annual general meeting of the British Institution of Mining Engineers met at University College, Sheffield, on September 19th, with Mr. C. H. Peak, of Walsall, presiding. It was reported that the number of members is now 2,075, a slight decrease compared with last year.

AT the annual meeting of the American Otological Society, Dr. Blake presented a resolution asking for coöperation with the National Association of Teachers of the Deaf and Dumb, to secure systematic examination of the pupils in deaf-mute schools throughout the United States, explaining the necessity of thorough and qualified investigation in order to select those pupils who could be most benefited by special teaching, or who perhaps by some treatment could be made better able to accept teaching.

THE Chambers of Commerce that met recently at Belfast, Ireland, urged upon the British Government the necessity of making the metric system compulsory. It was pointed out from consular reports, that much loss of trade has resulted in South America and elsewhere from Great Britain's adherence to the antiquated system.

MR. H. M. WHELPLEY, of St. Louis, has been collecting statistics in regard to the use of the metric system in physicians' prescriptions. It appears that of 1,008,500 prescriptions that have been examined, 6 per cent. were in the metric system. Reports were received from apothecaries in forty-two States and Territories. *The Pharmaceutical Era* from which we take this information earnestly advocates the metric system in medical prescriptions. It states that the system is taught in all pharmaceutical colleges but only in very few medical colleges.

THE city of Ithaca, N. Y., at the meeting of its Common Council, September 20th, followed the example of some of the largest cities of the State, including Buffalo, Rochester, Utica and Binghamton, and adopted voting machines. The contract guarantees their reliability and accuracy, is accompanied by a bond, not only for fulfillment of the contract in other respects, but also in the matter of possible patent litigation, makes the compensation payable out of the savings effected by use of the machines costing the city, in fact, nothing; while, in the end, not only providing what is claimed to be absolute insurance that no man shall lose his vote by defective or spoiled ballot, but also yearly profit by the change which, if capitalized at the city's rate of credit, 4 per cent., would amount to about one-half the city budget as fixed by its charter.

ADVICE has been received at Liverpool from the Malarial Investigation Expedition in West Africa, that the members of the Liverpool Commission, with the assistance of the colonial medical staff and others, have now started the operation of hunting for the anopholes (malarial mosquito) grub in water. This is a tedious but most important task, and necessitates a very careful inspection of all the ground in Freetown. So far these grubs have only been found in a shallow puddle and two tubs of stagnant water, but it is hoped that the minute inspection of the ground that is now being conducted will have satisfactory results. Dr. van Neck, the official delegate of the Belgian Government, who started from Antwerp after the English members had sailed, has now joined the expedition. In view of the importance of completing the expedition's researches, instructions have been cabled to Major Ross to use his own discretion as regards the date of his return. It is hoped that this

extension of time will enable the commission to complete its labors satisfactorily. The Secretary of State, of the Treasury of the United States, has written stating that he regrets that the invitation to send an American delegate was not received in time for the detail of an officer of the Marine Service Hospital to accompany the expedition.

A CORRESPONDENT of *Industries and Iron* of London, for whom its editor vouches as a competent judge, gives the following hindrances to introduction of the Nernst lamp: (1) There is no automatic heating arrangement to the small power lamps, and they each require about eight seconds in artificial heating to be brought to incandescence; (2) No small lamps of small candle power have yet been produced; (3) There are three wires to each, and the lamps cannot therefore be connected without inconvenience to existing standards; (4) Excepting mere laboratory tests there is no *practical* experience of the life of the lamp; (5) It has never yet been attempted to manufacture the lamp on a commercial scale, and not one lamp on the Nernst principle is yet in commercial use; (6) More than one firm of eminence have adopted the opinion that the principle of the lamp has been anticipated by the Jablochkoff candle, thus impeaching the validity of the Nernst patent.

UNIVERSITY AND EDUCATIONAL NEWS.

WE are glad to be able to give a correct account of Mrs. Hearst's plans for the University of California. Mrs. Hearst has not made any official announcement, and is not likely to do so, because she intends to superintend the use of her gifts herself. But the following may be considered as certain: She has by *will* devoted her fortune to the University—this in case of her death. But she intends to give during her lifetime all or the greater part, and from time to time as necessary to carry out her plans. She intends to commence next spring to put up two buildings, one of which is to be the mining building. It is not certain what the other will be. Besides there are good grounds for the belief that other wealthy residents of California, incited by Mrs. Hearst's example, will next year put up three other buildings. Mrs. Hearst has determined to live in Berkeley in order to be in closer touch with the University. It is expected that M. Bénard, the architect, will go to Berkeley to superintend the work. Negotiations to that effect are going on. Finally, it may be stated that Mrs. Hearst understands perfectly well that buildings require a corresponding endowment.

CORNELL UNIVERSITY opens with an entering class membership above 600. Sibley College has a freshman class of about 200 and many new men in the upper classes and graduate departments.

THE third course in advanced agricultural chemistry, in the School of Graduate Studies, of the Columbian University, Washington, D. C., will begin September 27th, under the direction of Dr. H. H Wiley. Graduates of agricultural colleges and other institutions of good standing, are eligible for admission to this course. Under certain restrictions graduates are admitted to the chemical laboratory of the department of agriculture. Advanced courses in soil studies, agricultural technical chemistry and in the study of food will be begun at once with laboratory practice. This school offers special advantages to the graduates of agricultural colleges who wish to complete their advanced studies in agricultural sciences.

A CHAIR of the theory, art and practice of education has been established in Owen's College, Manchester, and Mr. H. L. Withers, now principal of the training college at Isleworth, has been called to be the first incumbent.

DR. C. B. DAVENPORT, of Harvard University, has been called to the zoological department of the University of Chicago to fill the place left vacant by the removal of Professor Wheeler to the University of Texas.

W. D. MERRILL, PH.D. (Chicago), has been appointed instructor in biology, with special reference to botany, in the University of Rochester.

DR. CHARLES G. SHAW has been appointed to the position in the department of philosophy in New York University made vacant by the resignation of Dr. J. H. McCracken, to accept the Presidency of Westminster College, at Fulton, Mo.